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ABSTRACT

This document is one in a series which may be used in establishing a two year post secondary wastewater technology training program. The workbook provides the objectives of instruction; a means of standardizing instruction and evaluation; and approaches to instruction to maximize trainee involvement and retention. The guidelines are designed to provide practical, hands-on skill and knowledge directly related to the operation and management of a wastewater treatment plant. Specific process areas covered are pre-chlorination, screening and guiding, grit removal, aeration, primary and secondary sedimentation and first and second stage digestion. Each process covers such areas as: start-up and shut-down, normal operation, preventive maintenance, abnormalities, normal sampling and related safety factors. (CS)

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CRITERIA FOR THE ESTABLISHMENT & MAINTENANCE OF TWO YEAR POST HIGH SCHOOL WASTEWATER TECHNOLOGY TRAINING PROGRAMS

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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TRAINEE

CEWT

WORKBOOKS

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ENVIRONMENTAL PROTECTION AGENCY
CLEMSON UNIVERSITY

- TRAINEE WORKBOOKS

CRITERIA FOR THE ESTABLISHMENT AND MAINTENANCE OF TWO YEAR POST HIGH SCHOOL WASTEWATER TECHNOLOGY TRAINING PROGRAMS

ENVIRONMENTAL PROTECTION AGENCY

CLEMSON UNIVERSITY

AUGUST 1973

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Clemson University
Clemson, South Carolina

John H. Austin
Project Director

Robert L. Reynolds
Albert F. Eiss
Principal Consultants

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CLEMSON UNIVERSITY
CLEMSON, SOUTH CAROLINA 29631

COLLEGE OF ENGINEERING
DEPARTMENT OF
ENVIRONMENTAL SYSTEMS ENGINEERING

TELEPHONE
803/656-3276

27 August 1973

MEMORANDUM

TO: CEWT Implementing Institutions and Interested Parties

FROM: John H. Austin

SUBJECT: Trainee Workbooks for Use in Plant Operations Courses

The attached workbooks have been developed to serve as a guide for instructors of the Plant Operations courses. The workbooks have been developed from material in *Volume II: Curriculum Guidelines* of *Criteria for the Establishment and Maintenance of Two Year Post High School Wastewater Technology Training Programs* and subsequent materials developed by the CEWT project. In particular, the workbooks have been based on the documentation given in the *CEWT Informational Packet (Section C)* prepared for the March 29, 1972 meeting of CEWT implementing institutions. The model proposed was used by several developers and their revisions and suggestions used for the development of the workbooks attached.

The Trainee Workbook is a statement of what the trainee is to do at the end of a period of instruction. In fact, it contains the precise *answers* to all questions for which he is responsible. The workbook serves several purposes for the instructor. These include:

1. The workbook provides the objectives of instruction, i.e. the precise answers (and questions) that a trainee must be able to give after completing a unit of instruction. By providing objectives, the workbook suggests the content of the instruction and what the instructor must say, demonstrate, etc.

2. The workbook provides a means of standardizing instruction and evaluation of trainees. An evaluator can use the workbook to establish acceptable questions and answers for the trainee.

3. The workbook suggests approaches to instruction to maximize both the retention by the trainee and his involvement in the instructional process. This workbook is *NOT* to be handed to a trainee with the statement, *"Here's what you need to know--learn it."* The trainee would proceed to memorize the essential "answers" he needed to pass a test, probably with little understanding and with much less chance

of recall in the future. To minimize the chances of simple "answer memorization," the instructor will be encouraged to structure the note taking activities of his trainees during the lecture/discussion/demonstration/practice sessions in such a way as to have each trainee essentially "generate" the indicated "answers." Information learned in this way comes with much greater understanding on the part of the trainee. Consider the following question: *"What is the recommended frequency for inspecting the sludge wells as a part of the normal operation procedure?"* Hopefully, the instructor will *not* simply "tell" the trainee that the sludge well should be inspected at least once every hour. Rather, he will discuss with the trainee, *only to the extent clearly relevant*, the importance of the functioning of the sludge well, the possible problems of its not functioning properly, and other significant information. On the basis of this information, the trainee would be encouraged to determine a recommended frequency of inspection; the instructor will immediately confirm the correct answers and direct that the trainees record their answers in their handwritten workbooks in the appropriate form. Periodically, the instructor will examine and grade the handwritten workbooks and have each trainee correct any deficiencies in his workbook. Later, each trainee will be given a *printed* workbook for greater ease in study and reference. Having the trainee respond as described should greatly increase his active participation in the learning process--a characteristic found to be essential to effective and efficient learning.

The process units used in these workbooks are those that served as principal units in the CEWT program (see *Volume II: Curriculum Guidelines*). If the process unit in your curriculum is different than the one in the workbook, you need only change those sections of the workbook that are different and utilize the material that is common to your unit.

After you have used these workbooks, please give us your comments on improvements that we might consider. For further information on the CEWT project contact:

Mrs. Kay Bela
Educational Specialist for the National Impact
Training Activities Section
Water Quality Control
Manpower Training Branch
Office of Water Program Operations
Environmental Protection Agency
Washington, DC 20460

703-557-7499

JHA/jk

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

PRECHLORINATION

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
Technology Training Programs

U. S. Environmental Protection Agency
Office of Water Program Operations
Academic Training Branch

Clemson University
Clemson, South Carolina

August 1973

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Implementing Institutions

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Albany, Oregon
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Clemson, South Carolina
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This portion of the Trainee Workbook was developed in a cooperative effort by a panel of wastewater treatment plant personnel and the CEWT institutions. The first draft of this workbook was prepared by Jacques L. Bourque, Curriculum Development and Training Officer, Sanitary Engineering Branch, Ontario Ministry of the Environment, Toronto, Ontario; David Woodside, Technologist, Research Branch, Ontario Ministry of the Environment, Toronto, Ontario; and Judith A. Bourque, Toronto, Ontario.

Editorial work on the second draft of this manual was carried out by John S. Cox, Senior Class Research Assistant, Environmental Systems Engineering, Clemson University.

PRECHLORINATION

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START-UP PROCEDURE FOR PROCESS

Prepare for start-up of process as follows:

1. As needed, unload chlorine cylinder(s) (1 ton) from delivery truck by backing delivery truck flush to unloading platform.

2. Manually turn on electric power to hoist by placing switch in ON position.

3. Pick up hoist control box and test hoist as follows:
   (a) Push button marked UP. Hook on hoist cable should rise in vertical direction. If it does not rise, refer to corrective maintenance.
   (b) Push button marked DOWN. Hook on hoist cable should descend in vertical direction. If it does not descend, refer to corrective maintenance.
   (c) Push button marked FORWARD. Hoist carriage should move forward on track. If it does not move forward, refer to corrective maintenance.
   (d) Push button marked REVERSE. Hoist carriage should move in opposite direction to direction of movement in previous step. If it does not move in opposite direction, refer to corrective maintenance.

4. Using hoist, pick up the ton container lifting bar by inserting hoist hook in center clevice (ring) on bar.

5. Visually check end hooks on lifting bar by using hand to move one hook outwardly in horizontal direction. Allow hook to drop. Repeat for hook on other end. Hooks should fall freely when released. If they are "frozen," refer to corrective maintenance.

6. Remove the ton cylinder(s) from truck using hoist control box as follows:
   (a) Push button marked FORWARD or REVERSE to move hoist carriage in the direction required to center it over the ton cylinder to be removed from truck.
   (b) Push button marked DOWN and lower lifting bar lengthwise over cylinder. Insert end hooks under lip at each end of the cylinder.
   (c) Push button marked UP and raise cylinder high enough to clear any objects between unloading platform and cylinder storage area.
   (d) Push button marked FORWARD or REVERSE to move hoist carriage in direction required to move cylinder to storage area.
   (e) Using hands, swing cylinder while still suspended in air so that valve end can be connected to pigtail when cylinder is required for use.

Continued

(f) Push button marked DOWN and set cylinder down on pad with rollers. Manually remove the end hooks and push button marked UP to remove lifting bar out of way. Rotate cylinder until yellow square on end of cylinder having valves is at top of cylinder.

(g) Using hoist, as indicated in steps (b), (c), and (d), lift cylinder and move it to storage rack.

(h) Lower cylinder until properly seated in rack and lower lifting bar until hooks in the ends of the bar can easily by removed and lifted clear of the cylinder.

7. Repeat steps 6(a through h) until all chlorine cylinders have been removed from truck.

To change 1 ton cylinder on weight scale, proceed as follows:

1. Start exhaust system in chlorine room by putting switch in ON position.
2. Visually inspect fan and louvers to see if exhaust fan system is operating. If system is operating correctly (pulling air through room), continue procedure. If system is not operating correctly, refer to corrective maintenance.
3. Using wrench supplied by manufacturer, manually close cylinder valve connected to flexible hose by turning valve handle in counter-clockwise direction until closed snugly.
4. Manually close valve on end of flexible connection by turning handle to CLOSED position.
5. Manually close valve at flexible connection to header line by turning handle to CLOSED position.
6. Using two wrenches supplied by manufacturer, undo union nut connecting flexible connection to cylinder and pull end of flexible connection clear of cylinder.
7. Using hoist and lifting bar, unload cylinder following steps 3 to 6(d) in unloading and storing.
   WHY: to remove empty cylinder from scale to storage area and to move full cylinder from storage area to weigh scale.
8. Remove hoist and lifting bar away from scale area.
   WHY: if hoist and bar are left on cylinder connected to process, cylinder could be accidentally lifted or moved resulting in broken flexible connection and causing chlorine leak.
9. Using hands, remove protective cap from end of cylinder by loosening three square head bolts with wrench and rotating cap until notches line up with bolts. Pull cap forward until clear of bolts.

Continued

10. Place only one new lead washer in outlet recess so that it fits snugly.
    WHY: a new washer should be used because used lead washer has lost much of its ability to spread and seal, therefore, leaks will probably occur.

11. Using wrenches supplied by manufacturer, reconnect flexible connection to the LOWER valve on cylinder.
    WHY: a ton container has two valves, one above the other when cylinder is properly seated. The upper valve is used to draw off gas from container, whereas bottom valve is used to draw off liquid chlorine from cylinder to evaporator.

12. Open LOWER valve on cylinder by turning handle to OPEN position using wrench supplied by manufacturer.

13. Inspect for chlorine leaks by holding plastic bottle of ammonia under or close to (within 3 inches) cylinder valve connection, squeeze and note the formation of a white cloud of vapor, indicating a chlorine leak. If a leak is detected, put on gas mass immediately and close cylinder valve, turn chlorinator feed control counter-clockwise to maximum, leave chlorine room and close door and leave closed until all gas is exhausted from piping and room (so indicated when chlorine pressure reads ZERO). Refer to corrective maintenance for repair before proceeding. If no leaks are observed, continue with procedure.

14. Manually open header valve to allow chlorine to enter process.

To start up the evaporator, proceed as follows:

1. (a) Manually turn on water supply to evaporator by turning handle of water supply valve to OPEN position. Fill hot water tank to overflow level.

   (b) To activate automatic level control, manually turn 115-volt power supply to ON position. Observe solenoid valve opening by listening to water entering hot water tank. If there is no sound of water entering tank, refer to corrective maintenance for repair before proceeding. Visually observe green light is ON indicating alarm switch is energized. If not on, refer to corrective maintenance. When water level reaches bottom of sight glass, visually observe that alarm light goes from red to green, indicating contactor for control of heating elements is energized and low temperature alarm is activated. If light does not go from red to green, notify supervisor.

   (c) Observe closing of solenoid valve--indicating shutting off of water supply--by visually observing that water level has stopped rising when it reaches center of sight glass. If water level has not stopped, refer to corrective maintenance.

Continued

Start-Up Procedure for Process--Continued

2. Manually turn control knob on potentiometer of evaporator cathodic protection until green range is visually observed.

3. Manually turn on power supply to electric heater by turning switch to ON position and increase temperature to 160°F.

4. Pour one gallon of motor oil over the surface of the water to prevent evaporation as indicated by previous experience.

5. Manually open chlorine pressure-reducing valve by turning handle to OPEN position. Manually shut-off valve by turning handle to OPEN position.

SHUT-DOWN PROCEDURE FOR PROCESS

Prepare for shut-down of process as follows:

1. Verify that the chlorine room exhaust system is functioning properly as follows:

   (a) Manually push START button located on outside wall near door to start exhaust fan in chlorine room.

   (b) Enter chlorine room and immediately verify exhaust system is operating by visually observing that fan louvers are open (louvers are in horizontal position when open, in vertical position when closed).

   (c) Verify that fresh air is being drawn into chlorine room from adjacent areas by placing hand over louvered door.

   If any required function noted above is not in evidence, refer to corrective maintenance for repair before proceeding to any other procedures in the chlorine room.

   WHY: for safety reasons it is essential that the exhaust system (fan, motor, louvers) be operating properly at all times operator is in chlorine room--chlorine can kill quickly.

2. (a) Close cylinder valve as follows:

   (1) Locate and use only the wrench supplied by manufacturer. WHY: a standard pipe wrench or an otherwise ill-fitting manufacturer's wrench will damage the valve by rounding the square end of the valve stem; the use of longer wrenches could provide unnecessary leverage that could bend or break the valve stem.

   (2) Place wrench on valve stem and turn in clockwise direction until a snug closure is achieved without strained pulling and tugging.

   (3) Place wrench on valve stem so that when standing behind valve outlet the wrench handle sticks out toward your left side.

   (4) In the position just noted, grip valve stem firmly with right hand and hit wrench handle a sharp blow in a clockwise direction with the palm of the left hand.

   (b) Manually close auxiliary valve on end of pigtail by turning handle to CLOSED position.

   (c) Manually close manifold valve on pigtail leading to cylinder by turning handle to CLOSED position.

   (d) Allow chlorinator to continue operating for approximately 15 minutes without chlorine entering chlorinator. Pressure gage reading on chlorinator will drop to ZERO indicating complete purging of system.

   (e) Manually shut off water supply (injector) valve by turning handle to OFF position.

   (f) Manually shut off automatic control equipment: electric plug positioner, variable vacuum valve, or pneumatic valves.

Continued

Shut-Down Procedure for Process

(g) If system is shut down longer than 10 minutes, seal ALL chlorine lines from atmosphere by putting tape over open end of lines. WHY: to prevent possible corrosion of pipe caused by chlorine mixing with moisture from the air.

To shut down evaporator, proceed as follows:

1. Temporary shut-down (2-3 hours)
   - (a) Manually close the outlet valve on the evaporator by turning handle to CLOSED position.
   - (b) Leave ALL valves leading from chlorine container to evaporator to "push" the liquid chlorine back into the container and prevent over-pressurization of the chlorine lines or of the evaporator.
2. Long-term shut-down (greater than 3 hours)
   - (a) Manually close the outlet valve on the evaporator leading to the chlorinator for approximately 20 minutes by turning handle to CLOSED position.
     WHY: to allow the expanding chlorine gas in the evaporator to "push" the liquid chlorine back into the container and prevent over-pressurization of the chlorine lines or of the evaporator.
   - (b) After the initial 20 minutes, manually close the outlet valve on the chlorine container by turning handle to CLOSED position. Open the outlet valve on the evaporator to the chlorinator by turning handle to OPEN position.
   - (c) Visually observe gage on chlorinator until pressure drops to ZERO.
   - (d) Starting from the chlorine container, manually close ALL valves leading to the evaporator and then to the chlorinator by turning handle of each valve to CLOSED position.
   - (e) Manually cut power to evaporator heaters and controls by turning control switch to OFF.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURES

	Component/Step	Frequency
1.	Vent Fan	every 8 hours
2.	Chlorine Pressure Regulator [(PRV) in Chlorine Supply Line)	" " "
3.	Gas Rate Controller	" " "
4.	Rotameter and Float	" " "
5.	Valves (Water Line and Header)	" " "
6.	Cylinders	" " "
7.	Scales	every 24 hours
8.	Pneumatic Control Device (Plug Positioner)	every 8 hours
9.	Compressor (Belt Driven)	" " "
10.	Drive Belt	" " "
11.	Motor (Compressor)	" " "
12.	Air Storage Tank	" " "
13.	Recording Charts	" " "
14.	Alarm System (Chlorinator Vacuum and Pressure Alarm	every 24 hours
15.	Hoist	immediately before each use
16.	First Aid Kit	every 8 hours
17.	Fire Fighting Equipment	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

Component/Step	Frequency
1. Vent Fan	monthly
2. Chlorine Pressure Regulator [(PRV) in Chlorine Supply Line]	semi-annually
3. Gas Rate Controller	annually
4. Rotameter and Float	monthly
5. Valves (Water Line and Header)	"
6. Scales	semi-annually
7. Pneumatic Control Device (Plug Positioner)	every 2 months
8. Compressor (Belt Driven)	every 2 weeks
9. Motor (Compressor)	semi-annually
10. Air Storage Tank	weekly
11. Recording Charts	monthly
12. Alarm System (Chlorinator Vacuum and Pressure Alarm)	weekly
13. Hoist	semi-annually
14. First Aid Kit	weekly
15. Fire Fighting Equipment	annually

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

1. Odor

   (a) Scent like bleach: smelled by operator.
   CAUSE: excessive prechlorination.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Grab--influent

FREQ: at least once every 8-hour shift.
ACT: use clean sampling apparatus and dip sample from wastestream at the point the wastestream enters the plant, pour into clean container, cap, and immediately place in lab refrigerator. Avoid scraping the walls or floor. (The volume of sample taken must correspond to the flow rate at the time the sample is taken.)

(a) Divide the volume per sample by the average daily flow of wastewater through the plant (assume 5 MGD).

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5\ \text{MGD}} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}}$$

(b) Multiply the sample volume per 1 MGD (from part (a) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD):

$$\text{10:00 a.m. sample} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}} \times 7.0\ \text{MGD} = 0.70\ \ell = 700\ m\ell$$

2. Grab--effluent

FREQ: at least once every 8-hour shift.
ACT: use clean sampling apparatus and dip sample from wastestream at the point the wastestream leaves the plant, pour into clean container, cap, and immediately place in lab refrigerator. Avoid scraping walls or floor. (The volume of sample taken must correspond to the flow rate at the time the sample is taken.)

(a) Divide the volume per sample by the average daily flow of wastewater through the plant (assume 5 MGD).

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5\ \text{MGD}} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}}$$

(b) Multiply the sample volume per 1 MGD (from part (a) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD).

$$\text{10:00 a.m. sample} = 0.1\ \ell/\text{sample} \times 7.0\ \text{MGD} = 0.70\ \ell = 700\ m\ell$$

MAJOR SAFETY FACTORS

1. Prevent splashing of sewage into the eyes or other body openings.
WHY: pathogenic organisms that abound in sewage water can cause infection.

2. Wash the hands after taking sewage samples.
WHY: organisms can be introduced into the body by careless sanitary practices

NORMAL PROCEDURES, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

VENT FAN

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: blades on vent fan turning, air being exhausted to atmosphere; no unusual sounds, such as blades scraping against a surface. Motor running with even hum, free of vibration, shaft turning.
   ACT: operator listens for unusual sound, feels motor for heat and vibrations.

2. POSSIBLE MALFUNCTIONS

   (a) Fan blades do not turn freely: seen and/or heard by operator.
   REF: fan manufacturer's maintenance manual.
   IMM OP ADJ: manually turn fan to OFF position. Remove fuses. Place red LOCK-OUT-TAG on power to unit switch and padlock switch handle in OFF position. Notify supervisor and refer to corrective maintenance.

   (b) Louvers do not open when fan is turned on: seen by operator.
   REF: fan manufacturer's maintenance manual.
   IMM OP ADJ: manually turn fan to OFF position. Remove fuses. Place red LOCK-OUT-TAG on power to unit switch and padlock switch handle in OFF position. Notify supervisor and refer to corrective maintenance.

   (c) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: fan manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance before proceeding.

   (d) Motor stopped (shaft not turning): seen by operator.
   REF: fan motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button (if reset motor fails to continue running, manually cut power to motor by turning control switch to OFF). Notify supervisor and refer to corrective maintenance before proceeding.

   (e) Excessive vibration: seen and/or felt by operator.
   REF: fan motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance before proceeding.

   (f) Unusual noise: heard by operator.
   REF: fan motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance before proceeding.

Continued

3. PREVENTIVE MAINTENANCE
REF: fan motor manufacturer's maintenance manual.
FREQ: monthly.
COND:
(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): seen by operator.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:
(a) Manually turn fan motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use sound ladder when preventive maintenance is at a high position or dangerous position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned causing possible motor damage.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant can damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn fan motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component. WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent. WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use sound ladder if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

CHLORINE PRESSURE REGULATOR [(PRV) IN CHLORINE SUPPLY LINE]

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: input pressure from cylinder greater than output pressure from pressure regulator (each pressure given on pressure gages).
   ACT: operator observes both input and output pressure on pressure gages.

2. POSSIBLE MALFUNCTIONS

   (a) Input pressure from cylinder and output pressure from pressure regulator are equal: seen by operator on pressure gages.
   REF: chlorine pressure regulator manufacturer's maintenance manual.
   IMM OP ADJ: manually turn pressure regulator valve adjustment to try and correct. If unsuccessful, notify supervisor, manually close shut-off valves before and after pressure regulator, and manually open by-pass valve around PRV.

   (b) Chlorine leak from PRV (distinct odor and/or cloud using ammonia cloth): smelled and/or seen by operator.
   REF: chlorine pressure regulator manufacturer's maintenance manual.
   IMM OP ADJ: manually turn pressure regulator valve adjustment to try and correct. If unsuccessful, notify supervisor, manually close shut-off valves before and after pressure regulator, manually open by-pass valve around PRV.

   (c) Complete loss of pressure to chlorinator (gage reading this drop in pressure): seen by operator.
   REF: chlorine pressure regulator.
   IMM OP ADJ: manually turn pressure regulator valve adjustment to try and correct. If unsuccessful, notify supervisor, manually close shut-off valves before and after pressure regulator, and manually open by-pass valve around PRV.

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Manually start exhaust fan in chlorine room by pushing START button located on wall outside door.

   (b) Put on air pack or mask as indicated by instructions before entering chlorine room if there is distinct odor and/or cloud. (Otherwise, air pack should be close by.)

   (c) Manually shut-off cylinders by valves and operate chlorinator until pressure reads zero; then shut off chlorinator.

Continued

(d) Manually close isolating valves before and after regulator on line and manually open by-pass valve.

(e) Squeeze plastic ammonia bottle near shut-off isolating valves (within 3 inches). (A white vapor will form if there is a chlorine leak.) Notify supervisor and refer to corrective maintenance if there is a chlorine leak.

(f) Disconnect pipe and pressure reducing valve union and remove valve (regulator) after separation of union as indicated by maintenance manual. (Put plastic tape over ends of pipe if valve is removed for over one hour to prevent corrosion of pipe interior due to moisture collection.)

(g) Inspect and clean valve according to manufacturer's specifications. Replace valve if wear or malfunction exceeds specifications indicated.

(h) Place valve back into position, connect pipe and pressure reducing valve union as indicated by manual.

(i) Manually close by-pass valve and manually open isolating valves before and after regulator on line.

(j) Squeeze plastic ammonia bottle near valve and pipe connections (within 3 inches). (A white vapor will form if there is a chlorine leak.) Notify supervisor for further maintenance if there is a leak.

(k) Manually turn chlorinator switch to ON and manually open valves to cylinders. Watch pressure gage while chlorinator operating to verify that pressure rises above zero. If it does not, notify supervisor immediately.

(1) When pressure has built up to proper level (indicated by previous experience), take mask off briefly to determine chlorine gas present. If none present, manually shut down exhaust fan by pushing STOP button located on wall outside door. (If smell persists, leave fan on approximately 30 minutes, return, and turn fan off.)

(m) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually start exhaust fan in chlorine room by pushing START button located on wall outside door before entering room.
WHY: to prevent build-up of chlorine fumes which could cause death to operator.

Continued

Chlorine Pressure Regulator--Continued

(b) Put on air pack or mask as indicated by instructions before entering chlorine room.
WHY: to avoid exposure of chlorine gas to operator which could cause severe sickness or death.

(c) Squeeze plastic ammonia bottle near shut-off valves and regulator valve (when reinstalling).
WHY: to discover chlorine leak which could cause sickness or death to operator.

GAS RATE CONTROLLER

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: flow of chlorine increases or decreases when gas rate controller is adjusted for the increase or decrease; movement of v-notch is smooth.
   ACT: operator turns gas rate control knob 1/4 turn clockwise, then counter-clockwise. Operator observes rotameter indicator to verify that it moves up or down; turns adjuster knob until indicator returns to original setting. If indicator does not move up and down, operator notifies supervisor immediately.

2. POSSIBLE MALFUNCTIONS

   (a) No control or erratic control indicated on feed rate indicator (does not increase or decrease): seen by operator.
   REF: gas rate controller manufacturer's maintenance manual.
   IMM OP ADJ: manually close header valve by turning handle to OFF. Notify supervisor and manually start up stand-by equipment (if provided).

   (b) Rack and pinion of adjuster seized or disconnected: seen and/or felt by operator.
   REF: gas rate controller manufacturer's maintenance manual.
   IMM OP ADJ: grasp gas rate control shaft in hand and manually raise or lower until desired feed rate obtained. Notify supervisor.

   (c) Broken controller shaft: seen by operator.
   REF: gas rate controller manufacturer's maintenance manual.
   IMM OP ADJ: manually close header valve by turning handle to OFF. Notify supervisor and manually start up stand-by equipment (if provided).

   (d) V-notch not shutting properly (not going down completely, hanging): felt and/or seen by operator.
   REF: gas rate controller manufacturer's maintenance manual.
   IMM OP ADJ: manually close header valve by turning handle to OFF. Notify supervisor and manually start up stand-by equipment (if provided).

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Foreign material in v-notch: seen by operator.
   ACT: clean notch as directed by maintenance manual.
   GEN ACT:
   (a) Manually start exhaust fan in chlorine room by pushing START button located on outside wall near door.

Continued

(b) Manually shut off chlorine header valve by turning handle to CLOSE position.

(c) Operate chlorinator until pressure gage reads zero. (This will take approximately ten minutes.) Manually turn chlorinator switch to OFF.

(d) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(e) Manually turn chlorinator switch to ON.

(f) Manually open chlorine header valve by turning handle to OPEN position.

(g) Manually shut off exhaust fan in chlorine room by pushing STOP button.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually start exhaust fan in chlorine room by pushing START button located on outside wall near door.
WHY: to prevent build-up of chlorine gas which could cause severe illness or death of operator.

(b) Manually shut chlorine header valve by turning handle to CLOSE position.
WHY: to prevent accidental leakage of gas, while working on controller, which could cause severe illness or death of operator.

ROTAMETER AND FLOAT

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: rotameter float will move up or down inside tapered glass tube when flow rate controller knob is turned clockwise or counter-clockwise.
   ACT: operator increases or decreases chlorine gas flow by turning flow rate controller knob; looks at float to verify that it does move up and down.

2. POSSIBLE MALFUNCTIONS

   (a) Float inside rotameter is stuck: seen by operator.
   REF: rotameter and float manufacturer's maintenance manual.
   IMM OP ADJ: manually turn flow rate controller clockwise or counter-clockwise to see if float will jar loose. If unsuccessful, notify supervisor. Refer to corrective maintenance.

   (b) No vacuum in chlorinator (open adjuster flow rate controller and float remains at bottom of rotameter): seen by operator.
   REF: rotameter and float manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

   (c) No vacuum in chlorinator (O-rings are cracked and flattened. Rotameter float remains seated even when flow rate controller is turned in clockwise or counter-clockwise direction): seen by operator.
   REF: rotameter and float manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: rotameter and float manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Build-up of foreign material inside rotameter: seen by operator.
   ACT: remove rotameter as follows:
   (1) Enter from rear of cabinet.
   (2) Open the hinged panel covering rotameter.
   (3) Grasp rotameter at top with one hand and turn spiral release with the other.
   (4) Pull top of rotameter towards rear of cabinet and lift off bottom gasket.
   (5) Replace cracked or flattened gasket, reassemble, and close cabinet.

   GEN ACT:
   (a) Manually turn flow rate controller to OFF position.
   (b) Inspect for preceding condition and perform maintenance as indicated if necessary.

Continued

Rotameter and Float--Continued

(c) Manually turn flow rate controller to ON position.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn flow rate controller to OFF position.
WHY: to prevent possible injury to operator due to squirting water.

VALVES (Water Line and Header)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: valves that should be open are open; valves that should be closed are closed (valve positions to be obtained from supervisor). Valve handle turns easily when turned in clockwise or counter-clockwise direction. No leaks evident around packing.
   ACT: operator looks at the position indicator of each valve; visually inspects for leaks (uses ammonia check with header valve); operator turns valve handle from OPEN to CLOSE (or vice versa).

2. POSSIBLE MALFUNCTIONS

   (a) Handle frozen: felt by operator (tries to turn handle).
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: put "out of service" sign on valve handle. Notify supervisor and refer to corrective maintenance.

   (b) Broken stem: seen by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: put "out of service" sign on valve handle. Notify supervisor and refer to corrective maintenance.

   (c) Leaking at packing on valve stem: seen by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: tighten packing nut with wrench until leak stops. If leak does not stop, notify supervisor and refer to corrective maintenance.

   (d) Valve turns hard: felt by operator (tries to turn valve).
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

   (e) Valve turns easily but won't close completely: seen and/or felt by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:
   (a) Wipe old grease from valve stem with rags.

   (b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.

Continued

(c) Use the proper size and type of valve handle to move valve through one complete cycle (completely open, then completely closed). If it does not completely open (close), refer to corrective maintenance.

(d) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Use the proper size and type of valve handle when turning valves. WHY: improper type valve handle may slip and cause injury to operator.

CYLINDERS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: cylinder connected to chlorinator; pressure gage indicating a chlorine gas pressure; no leaks shown by ammonia test; total weight on scale is more than tare weight of cylinder.
   ACT: operator looks at connections to chlorinator to verify connections are made; uses ammonia, which gives off white fumes in the presence of chlorine gas, to inspect for gas leaks; operator also takes reading of cylinder weight and contents.

2. POSSIBLE MALFUNCTIONS

   (a) Leak at chlorine cylinder valve packing: seen by operator.
   REF: safety manual.
   IMM OP ADJ: manually turn on exhaust fan by pushing START button. Notify supervisor.

   (b) Leak at cylinder fusible plug (chlorine odor): smelled by operator.
   REF: safety manual.
   IMM OP ADJ: manually turn on exhaust fan by pushing START button; refer to corrective maintenance.

   (c) Defective chlorine valve-"turning spindle" (operator attempts to close cylinder valve but cannot even though valve handle continued to turn): seen and felt by operator.
   REF: safety manual.
   IMM OP ADJ: none.

   (d) Chlorine gas leak at joint connecting auxiliary valve and adapter: seen and/or smelled by operator.
   REF: safety manual.
   IMM OP ADJ: manually start vent fan by pushing START button; close cylinder valve and replace as described by maintenance manual.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

SCALES

1. NORMAL PROCEDURE
FREQ: every 24 hours.
COND: loss of weight indicated on scale is same as the amount of chlorine used in the previous 24-hour period (weight loss determined by subtraction of present weight from previous weight; amount used is set by the plant procedure as to the amount of treatment).
ACT: operator reads total weight on scale and subtracts that from the previous reading; compares this valve with the valve of chlorine used.

2. POSSIBLE MALFUNCTIONS

(a) Scale readings do not change over 8-hour period (present reading same as previous reading): seen by operator.
REF: scale manufacturer's maintenance manual.
IMM OP ADJ: step-on and off scale two or three times to activate mechanism. If reading on scale still does not change, notify supervisor and refer to manufacturer's maintenance manual for corrective procedure.

(b) Scale readings not indicative of chlorine used (difference in readings not equal to valve obtained by plant procedure): seen by operator.
REF: scale manufacturer's maintenance manual.
IMM OP ADJ: step on and off scale two or three times to activate mechanism. If reading on scale still does not change, notify supervisor and refer to manufacturer's maintenance manual for corrective procedure.

(c) Scale does not register any reading: seen by operator.
REF: scale manufacturer's maintenance manual.
IMM OP ADJ: step on and off scale two or three times to activate mechanism. If reading on scale still does not change, notify supervisor and refer to manufacturer's maintenance manual for corrective procedure.

3. PREVENTIVE MAINTENANCE
REF: scale manufacturer's maintenance manual.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Manually start exhaust fan in chlorine room by pushing START button located on wall outside door.

(b) Manually shut chlorine cylinder valve by turning handle to OFF position. Remove cylinder(s) from scale.

Continued

(c) Remove platform and all access plates to scale mechanism according to manufacturer's maintenance manual.

(d) Inspect all knife edges, linkages, swivels, and counterbalances for rust, wear, positioning, and other maintenance problems indicated in maintenance manual.

(e) Clean and lubricate where required with proper type and amount of lubricant. (Refer to manufacturer's maintenance manual.)

(f) Replace platform and all access plates to scale mechanism according to manufacturer's maintenance manual.

(g) Replace cylinder(s) on scale and manually open chlorine cylinder valve by turning handle to ON position.

(h) Manually shut off exhaust fan in chlorine room by pushing STOP button after all gas fumes are gone.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually start exhaust fan in chlorine room by pushing START button located on wall outside door.
WHY: to prevent build-up of chlorine gas which can cause severe sickness or death of operator.

(b) Manually shut chlorine cylinder valve by turning handle to OFF position.
WHY: to prevent possible leakage of gas which can cause severe sickness or death of operator.

PNEUMATIC CONTROL DEVICE (Plug Positioner)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: chlorine feed rate varies in direct relation to flow or residual variations (effluent).
   ACT: operator inspects rate of feeding and compares this with flow through plant or residual of effluent; verifies that direct relation is existing.

2. POSSIBLE MALFUNCTIONS

   (a) Chlorine feed rate does not vary in direct relation to flow or residual variations (comparison of each rate of flow): seen by operator.
   REF: pneumatic control device manufacturer's maintenance manual.
   IMM OP ADJ: manually disconnect linkage from control device to chlorinator mechanism. Turn control knob on front of chlorinator to manually set chlorine feed rate to desired amount. Notify supervisor and proceed with corrective maintenance according to manufacturer's maintenance manual.

3. PREVENTIVE MAINTENANCE
   REF: pneumatic control device manufacturer's maintenance manual.
   FREQ: every 2 months.
   COND: none.
   GEN ACT:
   (a) Inspect air supply for proper pressure (indicated by instrument manual) by reading gages. If high or low pressure, notify supervisor.

   (b) Inspect by observation air filters for moisture or oil. Refer to manufacturer's maintenance manual if replacement of filters is necessary.

   (c) Verify by observation that the signal air supply is being received by the pneumatic controller (controller should read maximum when 15 psi of air pressure is received).

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

COMPRESSOR (Belt Driven)

1. NORMAL PROCEDURE
FREQ: once every 8 hours.
COND: compressor running smoothly, normal noise level as indicated by previous running, gear box temperature normal (can hold hand firmly on gear box for at least 30 seconds), no hot spots on compressor casing, oil level normal (indicated on oil stick), drive belts running smoothly, drive belts in good condition (no rips, severe cracks, or other deterioration visible to the eye), discharge pressure normal (indicated on pressure gage); possible small oil leaks (film).
ACT: operator listens to compressor for above conditions; feels gear box and compressor casing for temperature conditions stated above; operator looks at oil level and discharge pressure readings; listens for smooth running of drive belt while compressor running; looks at drive belt while compressor is not running; looks for any small oil leaks (film); if any leaks are found, operator wipes down equipment and notes leak for future inspection.

2. POSSIBLE MALFUNCTIONS

(a) Excessive vibration: felt or seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.

(b) Excessive gear box temperature: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.

(c) Hot spots on compressor casing: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor and refer to corrective maintenance.
WHY: hot spots indicate increased friction inside the case which in turn indicates a build up of foreign material or mechanical misalignment.

(d) Large oil leaks (puddle): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor and notify supervisor.

(e) Drive motor and compressor misalignment (possible indicated by rapid wearing on drive belts): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.
WHY: misalignment of drive unit and belts places abnormal stress on compressor components and will cause excessive wear.

Continued

(f) Compressor automatically shuts down due to safety device operation (trips alarm): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to drive motor to OFF. Determine which alarm shut the compressor down (whether low on pressure, low cooling water pressure, low gas suction pressure, low cylinder oil level, high gas temperature, or high oil temperature). Notify supervisor, correct problem as directed by compressor manufacturer's maintenance manual, or refer to corrective maintenance if necessary.
WHY: alarm conditions must be taken care of before trying to restart the compressor to prevent causing damage to the compressor.

(g) Loading valves not seating: observed by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to compressor drive to OFF. Notify supervisor and refer to corrective maintenance.
WHY: compressor will not pump properly if loading valves do not seat.

(h) Unusual noise (grinding, banging, scraping): heard by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to compressor drive to OFF. Notify supervisor and refer to corrective maintenance.

(i) Shaft not turning: seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to compressor drive to OFF. Notify supervisor and refer to corrective maintenance.

(j) No air delivery to storage tank (indicated by pressure gage): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to compressor drive to OFF. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: compressor manufacturer's maintenance manual.
FREQ: every 2 weeks.
COND:
(a) Output of compressor has reduced at increased rate: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.

(b) Internal wear (timing gear) exceeds manufacturer's tolerance allowance: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.
GEN ACT:
(a) Inspect for output condition of compressor in indicated manner.

Continued

(b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(c) Perform maintenance for output condition of compressor if necessary. (Refer any work that involves dismantling and reassembling of a compressor of this design to a qualified machinist.)
WHY: repairs require specialized knowledge and tools.

(d) Inspect for internal wear in indicated manner and perform maintenance if necessary. (Refer any work that involves dismantling and reassembling of a compressor of this design to a qualified machinist.)
WHY: repairs require specialized knowledge and tools.

(e) Inspect oil level in compressor sump and replace or add oil to FILL line if required. (If oil level is low, oil stick will indicate how low and the approximate amount of oil to add.) Fill with proper type and amount of oil as indicated by manufacturer's maintenance manual.

(f) Inspect the air filters visually to determine if they need to be cleaned or replaced. If caked with dirt, dust, and debri, manually remove filters and clean as indicated by maintenance manual. If filters damaged or corroded, replace with new filters.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up any spilled oil or grease with rags and/or absorbent.
WHY: to prevent slippery area which could cause operator to slip and fall, thus causing injury or death.

DRIVE BELT

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: belt transfers power from motor to driven pulley quietly and smoothly; no jerking or flapping noise as if belt is loose or torn; belt is in good condition (no tear, split, or severe cracking).
   ACT: operator listens to belt while motor is running; visually inspect belt while motor is not running.

2. POSSIBLE MALFUNCTIONS

   (a) Belt bounces (causes noise): heard by operator
   REF: drive belt manufacturer's maintenance manual.
   IMM OP ADJ: manually turn off power to drive belt motor by turning motor control to OFF position. Notify supervisor and refer to corrective maintenance.

   (b) Drive belt motor operating and driven pulley stopped or turning very slowly: seen and/or heard by operator.
   REF: drive belt manufacturer's maintenance manual.
   IMM OP ADJ: manually turn off power to drive belt motor by turning control to OFF position. Notify supervisor and refer to corrective maintenance.

   (c) Unusual noises (indicated by previous experience): heard by operator.
   REF: drive belt manufacturer's maintenance manual.
   IMM OP ADJ: manually turn off power to drive belt motor by turning control to OFF position. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS

   (a) Remove fuses for power to drive belt motor to prevent accidental starting of motor when performing corrective maintenance.
   WHY: to prevent mangling of fingers and possible death to operator due to injuries from entanglement of belts and motor.

MOTOR (Compressor)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: motor only warm, running with low even hum, free of vibration, shaft turning, bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
ACT: operator turns control switch to HAND (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

(a) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

(b) Motor stopped (shaft not turning): seen and/or heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button (if reset motor fails to continue running, manually cut power to motor by turning control switch to OFF; start alternate pump). Refer to corrective maintenance.

(c) Excessive vibration: seen or felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

(d) Unusual noise: heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

(e) Scorched paint or black stains on motor housing: seen by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: semi-annually.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connections could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

Continued

Motor (Compressor)--Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

AIR STORAGE TANK

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: pipe connections to tank(s) are tight, no hint of air leakage (such as hissing sound, drop showing on pressure gage on tank); pressure gage on tank showing required pressure.
   ACT: operator visually inspects pipe connections and listens for air leakage; looks at pressure gage.

2. POSSIBLE MALFUNCTIONS

   (a) Sound of air escaping, no pressure indicated on gage, air compressor operating: seen and/or heard by operator.
   REF: air storage tank manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power supply to compressor drive motor by turning switch to OFF position. Notify supervisor immediately.
   WHY: to protect compressor from overheating.

   (b) Tank and gage appear correct (indicated by previous experience), compressor starting and stopping at rapid intervals: seen and heard by operator.
   REF: air storage tank manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power supply to compressor drive motor by turning switch to OFF position. Notify supervisor immediately.
   WHY: to protect compressor from overheating.

3. PREVENTIVE MAINTENANCE
   REF: air storage tank manufacturer's maintenance manual.
   FREQ: weekly.
   COND: none.
   GEN ACT:
   (a) Visually inspect air pressure gage to see if it is working. (Air pressure in tank should increase when compressor is operating.) If not working, refer to corrective maintenance.

   (b) "Bleed off" from valve in bottom of air storage tank by partially opening valve manually to remove any condensed liquids from inside the tank. Manually close valve after liquids are drained out. (If air storage tank is located near air compressor, manually turn off compressor motor, padlock electrical power supply switch in OFF position and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.

   (c) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up which could cause serious injury to operator.

RECORDING CHARTS

1. NORMAL PROCEDURE
   FREQ: every 8 hours.
   COND: pen indicating correct time on chart (pen at same time marking on chart as the hands are on watch or clock face). Pen marking chart in response to signal (marking is approximately at same reading as at previous same time of day; or pen moves up as operator increases flow). Correct chart on unit (24 hours or 7 day). Chart is turning smoothly.
   ACT: operator compares time on chart with actual time; operator looks at chart markings as signals are relayed; inspects chart to verify correct chart (indicated by procedure of plant); verifies by observation that chart is moving smoothly.

2. POSSIBLE MALFUNCTIONS

   (a) Chart not turning: seen by operator.
   REF: recording chart manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor. Refer to recording chart manufacturer's maintenance manual for corrective procedure.

   (b) Chart drive not turning: seen by operator.
   REF: recording chart manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor. Refer to recording chart manufacturer's maintenance manual for corrective procedure.

   (c) Pen not in contact with chart: seen by operator.
   REF: recording chart manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor. Refer to recording chart manufacturer's maintenance manual for corrective procedure.

   (d) Pen not marking chart: seen by operator.
   REF: recording chart manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor. Refer to recording chart manufacturer's maintenance manual for corrective procedure.

3. PREVENTIVE MAINTENANCE
   REF: recording chart manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:

   (a) Inspect chart securing unit (visually and with hands). If the chart is loose or shaky, refer to recording chart manufacturer's maintenance manual for corrective procedure.

   (b) Clean pen with fingers or with cheese cloth.

   (c) Visually inspect point of pen. If point is clogged after cleaning, leaking excessive ink, or writing sloppily, refer to manufacturer's maintenance manual for corrective procedure.

Continued

Recording Charts--Continued

(d) Inspect chart drive for operation by seeing chart move according to hour on clock.

(e) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

ALARM SYSTEM (Chlorinator Vacuum and Pressure Alarm)

1. NORMAL PROCEDURE
FREQ: every 24 hours.
COND: no alarm condition (bell is not ringing); control panel shows there is no alarm condition.
ACT: operator listens for alarm bell; looks at main control panel.

2. POSSIBLE MALFUNCTIONS

(a) Alarm sounding, control panel shows there is no alarm condition: seen and heard by operator.
REF: chlorinator manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

(b) Alarm not sounding, control panel shows there is an alarm condition: seen and heard by operator.
REF: chlorinator manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: chlorinator manufacturer's maintenance manual.
FREQ: weekly.
COND: none.
GEN ACT:
(a) Inspect alarm system for pressure alarm as follows:

(1) Manually shut off valve in chlorine line by turning handle to CLOSE position to prevent chlorine from entering chlorinator.

(2) Listen for sound of alarm (should hear sound soon after chlorine pressure indicated on pressure gage reads zero).

(3) If alarm does not sound off in allotted time, notify supervisor and refer to corrective maintenance. If alarm does sound off, proceed to step (4).

(4) Manually open chlorine valve and reset alarm by pushing alarm button on main control panel.

(b) Inspect alarm system for chlorinator vacuum alarm as follows:

(1) Manually shut off water supply to the injector of the chlorinator by closing the valve in the supply line.

(2) Listen for sound of alarm (after approximately one minute), alarm should ring.

(3) If alarm does not sound off in allotted time, notify supervisor and refer to corrective maintenance. If alarm does sound off, proceed to step (4).

(4) Manually open valve in water line to injector by turning handle to OPEN position.

(5) Reset alarm system by pushing alarm button on main control button.

Alarm System--Continued

(c) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

HOIST

1. NORMAL PROCEDURE
FREQ: immediately before each use.
COND: hoist cable moves easily up or down (no jerking or stopping); hoist moves easily forward or in reverse on track (no jerking or stopping); lifting bar in good condition (no cracks or fractures, not bent out of shape).
ACT: operator pushes button marked UP, then pushes button marked DOWN; verifies by observation that cable moves in these indicated directions. Operator then pushes button marked FORWARD, then pushes button marked REVERSE; verifies by observation that cable moves in these indicated directions. Operator visually inspects lifting bar for preceding conditions listed above.

2. POSSIBLE MALFUNCTIONS

(a) Hoist cable will not move UP or moves up with jerky motion (operator pushes button marked UP): seen by operator.
REF: hoist manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor.

(b) Hoist cable will not move DOWN (operator pushes button marked DOWN): seen by operator
REF: hoist manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor.

(c) Hoist carriage will not move FORWARD (operator pushes button marked FORWARD): seen by operator.
REF: hoist manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor.

(d) Hoist carriage will not move in REVERSE on track (operator pushes button marked REVERSE): seen by operator.
REF: hoist manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: hoist manufacturer's maintenance manual.
FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn off control switch, use "out of service" sign and lock control switch handle in OFF position when working on component.

(b) Visually inspect gears, chain, cable, and bearings for wear using the specifications in maintenance manual to determine what excessive wear is. If wear is excessive, refer to corrective maintenance for repair.

Continued

Hoist--Continued

(c) Lubricate the gears, chain, and other essential parts that require lubrication with the proper type and amount of lubricant called for by the maintenance manual.

(d) Clean up all spilled and excessive lubricant with rags and/or absorbent.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn off control switch, use "out of service" sign, and lock control switch handle in OFF position when working on component.
WHY: to prevent injury or death to operator due to accidental start-up.

(b) Clean up all spilled and excess lubricant with rags and/or absorbent.
WHY: to prevent possible injury to operator due to slippery working area.

FIRST AID KIT

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed on inventory sheet in kit.
ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies; observes position of kit.
WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

(a) Kit is missing: seen by operator.
REF: none.
IMM OP ADJ: notify supervisor.

(b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
REF: first aid kit manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: first aid kit manual.
FREQ: at least once every week.
COND:
(a) Some supplies missing: seen by operator.
ACT: determine actual amount of supplies missing.
GEN ACT:
(a) Replenish first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
FREQ: at least once every 8 hours.
COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshal.
ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

(a) Equipment missing: seen by operator.
REF: none.
IMM OP ADJ: notify supervisor.

(b) Equipment damaged: seen by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: fire fighting maintenance manual.
FREQ: annually.
COND:
(a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
GEN ACT:
(a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
WHY: low weight indicates extinguisher should be recharged.

(b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is now low.

(c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

SCREENING AND GRINDING

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
Technology Training Programs

U. S. Environmental Protection Agency
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Academic Training Branch

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START-UP PROCEDURE FOR PROCESS

1. Inspect barscreen and channel of unit prior to start-up as follows:
   (a) Verify by observation that channel is free of tools, ladders, and debris (remove items if necessary).
   (b) Verify by observation that motor, gear reducer, sprockets, chains, rakes, and rake wiper are free of tools and debris (remove items if necessary) and are properly positioned for normal operations (put in proper position if necessary).
   (c) Verify by observation that all personnel are clear of unit and are aware of start-up (inform personnel who are present).
   (d) Inspect speed reducer for sufficient amount of lubricant. Add lubricant if needed.
   (e) Visually inspect switch gear for proper nomenclature as indicated by plant manual.
   WHY: to prevent mechanical damage to unit.

2. Verify that the barscreen of the unit is operational by doing the following:
   (a) Start motor by turning control switch to HAND.
   (b) Verify by observation that motor, gear reducer, sprockets, chains, rakes, rake wiper, sprays, and particularly those parts of the unit that normally run under water are moving properly and produce no unusual sounds. *If any component is not functioning properly, refer to corrective maintenance before proceeding.*
   (c) Stop unit by turning motor control switch to OFF.

3. Put barscreen on line by doing the following:
   (a) Manually close drain valve by turning handle clockwise.
   (b) Equalize water head on isolation gates by opening butterfly valve and allowing water level to become the same on both sides of the gates.
   (c) Pull isolation gates out of channel by using overhead crane.
   (d) Hose gates clean by using high pressure hose.
   (e) Store gate in gate storage pit by using overhead crane.
   (f) Start barscreen by turning motor control switch to HAND.
   (g) Observe operation of barscreen for five minutes. *If any components listed in 2(b) are not functioning properly, refer to corrective maintenance before proceeding.*
   (h) Turn bubbler air supply valve to ON position.
   (i) Set air flow through rotometer indicator to pre-determine set point (as indicated in plant developed operational manual).
   (j) Turn motor control switch to AUTO position. Verify by observation sluice water is flowing. *If any component in 2(b) is not functioning properly, refer to corrective maintenance before proceeding.*

4. Put grinder on the line by doing the following:
   - (a) Refer to plant developed operational manual to determine that the grinder sump water level is normal. If water level is high, turn drainage valve to OPEN and allow water level to drop until normal. Turn valve to CLOSED. If water level is low, turn intake valve to OPEN and allow water level to rise until normal. Turn valve to CLOSED.
   - (b) Verify that the grinder suction and discharge valves are open by turning them counter-clockwise.
   - (c) Release LOCK-OUT-STOP switch manually.
   - (d) Start grinder by moving motor control switch to AUTO.
   - (e) Verify by observation that motor, coupling, and grinder operate smoothly and produce no unusual sounds. *If any component is not functioning properly, refer to corrective maintenance before proceeding.*
   - (f) Test reversing cycle of grinder by depressing reverse control button. *If any components in 4(e) are not functioning properly, refer to corrective maintenance before proceeding.*
   - (g) Observe grinder discharge to verify that the flow is normal as indicated in plant developed operations manual, and that the screenings are being shredded to a size not exceeding 1/4 inch in diameter.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Put alternate unit into service.

2. Install upstream isolation gate by using overhead crane.

3. Install downstream isolation gate by using overhead crane.

4. Turn barscreen motor control switch to HAND.
   WHY: to assure removal of all collected material from screen and rakes while draining channel.

5. Remove gratings from over channel manually and stake beside channel.

6. Put up barricades and/or ropes around open channel.

5. Open drain valve by turning handle counter-clockwise.

6. As water level in channel recedes, use high pressure hose to hose down channel walls, floor, and screening equipment.
   WHY: if underwater growths are allowed to air dry, they will adhere and cause odor problems; solids that have dried are difficult to remove.

7. Turn barscreen motor control switch to OFF.

8. Insert LOCK-OUT-STOP switch bar.

9. Turn grinder motor control switch to OFF.

10. Open barscreen motor electrical power breaker, padlock breaker handle in OPEN position, and attach LOCK-OUT-TAG.
    WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

11. Open grinder motor electrical power breaker, padlock breaker handle in OPEN position, and attach LOCK-OUT-TAG.
    WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

12. After water has drained out, inspect by visual observation for water leakage. If water leakage is present, attempt to reseat gate with overhead crane by raising gate approximately one foot or less and then lowering it back into position. If water leakage is still present, notify supervisor.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

Component/Step	Frequency
1. Remote Readouts and Indicators	every hour
2. Motor (Rake Drive)	every 4 hours
3. Gear Reducer (Rake Drive)	" " "
4. Shear Pin and Alarm Trigger	" " "
5. Primary Drive Chain	" " "
6. Sprockets and Shafts	" " "
7. Rake Chains	" " "
8. Rakes	" " "
9. Rake Wiper	" " "
10. Rake Sprays	" " "
11. Screenings Sluiceway and Flushing Water Valve	" " "
12. Bar Rack	" " "
13. Bubbler Tubes	" " "
14. Motor (Grinder Drive)	" " "
15. Coupling (Grinder)	" " "
16. Grinder	" " "
17. Grinder Sump	" " "
18. Grindings Return Sluiceway	" " "
19. Channel Isolation Gates	every 8 hours
20. Drain Valves	" " "
21. Timers	" " "
22. Rake Positioning Switch	" " "
23. Piping and Valves	" " "
24. First Aid Kit	" " "
25. Fire Fighting Equipment	" " "
26. Grinder Sump	" " "
27. Influent Sampling	every 2 hours

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

Component/Step	Frequency
1. Grindings Return Sluiceway	every 8 hours
2. Screenings Sluiceway and Flushing Water Valve	semi-annually/annually
3. Grinder	semi-weekly
4. Sprockets and Shafts	weekly/monthly
5. Motor (Rake Drive)	monthly
6. Primary Drive Chain	"
7. Rake Chains	"
8. Rake Wiper	"
9. Rake Sprays	"
10. Motor (Grinder Drive)	"
11. Piping and Valves	"
12. Coupling (Grinder)	quarterly
13. Gear Reducer (Rake Drive)	semi-annually
14. Shearpin and Alarm Trigger	"
15. Bar Rack	"
16. Drain Valves	"
17. Timers	"
18. Sprockets and Shafts	monthly
19. Rake Positioning Switch	semi-annually
20. Piping and Valves	"
21. Channel Isolation Gates	annually
22. Remote Readouts and Indicators	"
23. Fire Fighting Equipment	"
24. First Aid Kit	"

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS

1. Color

   (a) Black: seen by operator.
   CAUSE:
   (1) Waste has turned septic because of:
      a. low flow in collection system.
      b. its high temperature.
      c. extended stay in collection system.
      d. shock load of toxic materials introduced into collection system.

   (b) Any color not normal for a particular plant (determined by entries of abnormalities in plant operations log): seen by operator.
   CAUSE: unusual industrial waste being introduced into collection system.

2. Odor

   (a) Scent like rotten eggs: smelled by operator.
   CAUSE:
   (1) Waste has turned septic (thereby generating H_2S) because of:
      a. low flow in collection system.
      b. its high temperature.
      c. extended stay in collection system.
      d. shock load of toxic materials introduced into collection system.

   (b) Scent like petroleum products: smelled by operator.
   CAUSE: dumping of petroleum products (gas, oil, kerosene, etc.) by industry and business (service stations, etc.).

   (c) Scent like bleach: smelled by operator.
   CAUSE: excessive prechlorination.

3. Debris in Influent to Process

   (a) Sand: seen on rakes by operator.
   CAUSE:
   (1) Storm runoff has carried sand into collection system.
   (2) Broken collection sewer has allowed sand to enter.
   (3) Illegal disposal of sand into open manholes.

Continued

(b) Rocks: seen on rakes by operator.
CAUSE:
(1) Broken collection line has allowed rocks to enter collection sytem.
(2) Sewer construction activities has allowed rock to enter system.

(c) Concrete or Tile: seen on rakes by operator.
CAUSE:
(1) Sewer line broken, concrete or tile from broken area carried to plant.
(2) Sewer construction has allowed concrete to enter sewer.

(d) Tires, Trees, etc.: seen on rakes by operator.
CAUSE:
(1) Illegal disposal of materials into manholes upstream.

4. Debris in Effluent from Screens

(a) Rocks, concrete, tile, trees, etc.: seen by operator.
CAUSE:
(1) Debris allowed to bypass barscreens.
(2) Areas of screen broken.

5. Debris in Effluent from Grinder

(a) Grindings are noticeably larger than usual and/or they tend to string together to form larger masses: seen by operator
CAUSE:
(1) Improper grinder adjustment.
(2) Dull and/or broken cutters.
(3) Grinder teeth are missing.
(4) Grinder setting has slipped.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Composite--influent

FREQ: one sample each 8-hour shift (each sample consisting of at least 4 parts; one part every 2 hours or less).
ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream enters the plant. When dipping sample do not touch channel sidewalls and do not include larger chunks of material in sample. Pour sample into a clean container, cap, and immediately place in laboratory refrigerator.
WHY: large solids or material scraped from the side wall will not give a representative sample of the influent. The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, influent composite sample for 8:00 A.M.--4:00 P.M. shift would be as follows:

Time Taken	Flow Rate, MGD	Volume of Sample, mℓ
10:00 a.m.	7.0	700
12:00 N	6.5	650
2:00 p.m.	6.0	600
4:00 p.m.	5.5	550
	Total Shift Sample	2500 mℓ

In the above example, 100 mℓ of sample were taken for each 1 MGD flow rate. Determination of this sample volume to flow rate ratio is as follows:

(a) Obtain from laboratory the total volume of sample needed to conduct tests for 24-hour period (assume 6 ℓ/day).

(b) Determine the number of samples to be taken in a 24-hour period (assume one every two hours).

$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed [from part (a)] by the number of samples to be taken [from part (b)] to obtain the average volume needed for each sample:

$$\frac{6}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5\ \ell}{\text{sample}}$$

(d) Divide the average volume per sample [from part (c) above] by the average daily flow of wastewater through the plant (assume 5 MGD).

$$\frac{0.5}{\text{sample}} \times \frac{1}{5 \text{ MGD}} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}}$$

Continued

Normal Sampling--Continued

(e) Multiply the sample volume per 1 MGD [from part (d) above] by the flow rate through the plant at the time of sampling (assume 10:00 A.M. flow rate is 7.0 MGD).

$$\text{10:00 A.M. sample} = \frac{\text{0.1 liter/sample}}{\text{1 MGD}} \times \text{7.0 MGD} = \text{0.70 liters} = 700\ m\ell$$

WHY: a composite sample will give a more accurate representation than a grab sample, because the wastestream characteristics are continually changing as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed.

MAJOR SAFETY FACTORS--None

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

CHANNEL ISOLATION GATES

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: gates in use or storage position.
   ACT: operator visually observes that the gates are in their proper position as indicated by the daily log sheets. If gates are not in proper position, notify supervisor.

2. POSSIBLE MALFUNCTIONS

   (a) Water leakage around gate: seen by operator.
   REF: plant design manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: plant developed operational manual.
   FREQ: at least annually.
   COND:
   (a) Seals are torn, cracked, or missing (water leaking when gates are in channel): seen by operator.
   ACT: refer to corrective maintenance for seal replacement.
   GEN ACT:
   (a) Follow SHUT-DOWN-PROCEDURE.
   (b) Grease butterfly valve with grease gun using lubricant as indicated in manufacturer's maintenance manual.
   (c) Enter (exit) the channel using a sound ladder.
   (d) Inspect for preceding condition in indicated manner and perform maintenance if necessary.
   (e) Follow START-UP PROCEDURE FOR PROCESS.
   (f) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Put up barricades and/or ropes when gratings are removed.
   WHY: to prevent personnel from falling into open pits causing injury or death.

   (b) Enter (exit) the channel using a sound ladder.
   WHY: to prevent falls due to unsound ladder which may cause injury or death to operator.

MOTOR (Rake Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range given on name plate, motor running with low even hum, shaft turning, and bearings temperature normal (can hold hand firmly on bearing casing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is OFF) and makes the following observations: listens for unusual sounds, feels motor and bearing casing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Scorched paint and black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (d) Motor smoking: seen or smelt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (e) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(f) Unusual noise: heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: tighten motor mounts bolts with wrench after visual inspection for correct alignment.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint or black stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

GEN ACT:

(a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Tighten end plate bolts with wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

(d) Use grease gun to apply proper amount and type of lubricant as called for in manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(e) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn rake drive motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn rake drive motor control switch to OFF, bar lockout stop switch, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent accidental start-up that could cause injury to personnel.

(b) Clean up all spilled lubricant with rags and/or absorbents.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

GEAR REDUCER (Rake Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: oil level gage shows oil within normal levels as indicated on the stick markings. Oil leakage is no more than a few drops or a thin film on outside of housing. Gears are running at normal noise level as determined by previous experience.
   ACT: operator visually observes oil gage and housing. If necessary add proper oil as indicated by maintenance manual. Wipe up minor leakage of oil with rag. Listen to gear sounds.
   WHY: low oil level will cause excessive wear on gears. Proper type of oil is necessary to long life and smooth operation.

2. POSSIBLE MALFUNCTIONS

   (a) Turning gear makes unusual noise (determined by previous experience): heard by operator.
   REF: manufacturer's maintenance guide.
   IMM OP ADJ: manually cut power to gear drive by turning rake drive motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual.

   (b) Major leak of oil (oil puddle under gear box and/or thick film of oil on housing): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to gear box by turning rake drive motor control switch to OFF; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual.

3. PREVENTIVE MAINTENANCE
   REF: gear reduction unit manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Operator flushes and replaces oil as follows:

      (1) Remove drain plug with wrench and drain old oil into container.
      WHY: to remove impurities and accumulated foreign matter with old oil.

      (2) Flush with new oil.
      WHY: to remove impurities and accumulated foreign matter not removed with old oil.

Continued

(3) Replace plug with wrench and fill with proper type and amount of oil as indicated by gear reducer manufacturer's maintenance manual.
WHY: addition of proper type and amount of oil is necessary to long life of gears.

(c) Clean area of oil spillage or leakage with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn rake drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: surprise start-up could cause loss of fingers or worse injury to operator.

(b) Clean area of oil spillage or leakage with rags and/or absorbent.
WHY: reduces chances of operator slipping and falling causing injury.

SHEAR PIN AND ALARM TRIGGER

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: the drive flanges are turning together at the speed indicated by the plant developed operational manual; the shear pins are not broken and are in the proper positions as indicated by the plant developed operational manual; the trigger arm is in the cocked position; the trigger arm is clearing the alarm switch lever by an estimated 1/8 inch.
   ACT: operator verifies the preceding conditions by visual observation.
   WHY: a broken shear pin will allow the drive flange to turn without turning the driven flange; an improperly positioned shear pin may be loose and either fall out or not shear at the proper position; correct positioning of trigger arm as indicated by plant developed operational manual is necessary to activate the alarm switch during a drive flange malfunction which will send a remote alarm indication.

2. POSSIBLE MALFUNCTIONS

   (a) The remote alarm sounds indicating drive flange and driven flange are not turning together: heard by operator.
   REF: screen manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Remote alarm is being sounded but drive flange and driven flange are turning together at proper speed (trigger arm is out of adjustment): heard and seen by operator.
   REF: screen manufacturer's maintenance manual.
   IMM OP ADJ: cut power to alarm by turning alarm control switch to OFF. Refer to corrective maintenance.

   (c) Shear pin is working its way out of the flange holes: seen by operator.
   REF: screen manufacturer's maintenance manual.
   IMM OP ADJ: cut power to drive motor by turning control switch to OFF. Refer to corrective maintenance.
   WHY: the shear pin might drop out of the flange allowing the motor to turn without moving the rakes.

3. PREVENTIVE MAINTENANCE
   REF: barscreen manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.

Continued

GEN ACT:

(a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Brace flanges as indicated in plant developed operational manual.
WHY: the bar rakes are heavy and may turn the drive chains a short distance when a shear pin is removed even though the power to the drive motor is in OFF position.

(c) Loosen set screw with screwdriver and remove shear pin.

(d) Clean flange faces and coat faces with oil designated by manual.
WHY: the flanges may rust or seize together allowing excessive torque to be applied to the primary drive chain.

(e) Replace shear pin and tighten set screw with screwdriver. Unbrace flanges.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn rake drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Brace flanges as indicated in plant developed operational manual.
WHY: the bar rakes are heavy and may turn the drive chains a short distance when a shear pin is removed, even though the power to the drive motor is in OFF position, causing loss of fingers to operator.

PRIMARY DRIVE CHAIN

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: no more than two (2) estimated inches sag, chain has no breaks.
   ACT: operator looks at chain while unit is in operation.

2. POSSIBLE MALFUNCTIONS

   (a) Too much slack (more than 2 estimated inches sag): seen by operator.
   REF: screen manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance for adjustment.
   WHY: if chain is too slack, damage may occur to chain or sprockets causing expensive repairs and/or extensive down time.

   (b) Broken or cracked chain: seen by operator.
   REF: screen manufacturer's maintenance manual.
   IMM OP ADJ: cut power to drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: barscreen manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Chain showing signs of wear (links' diameters estimated 1/4 of original diameter): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: to allow scheduled maintenance and avoid unexpected breakdown.

   (b) Links or link pins broken or cracked: seen by operator.
   ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Manually turn drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Hose chain down using high pressure hose.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Lubricate chain using proper lubricant as indicated in manufacturer's maintenance manual.

Continued

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

SPROCKETS AND SHAFTS

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: the sprockets and shaft are turning together at the proper speed indicated by the plant developed operational manual (the sprockets are tight on the shaft); the teeth are all there and meshing properly with chain links.
   ACT: operator verifies by visual observation the preceding conditions.

2. POSSIBLE MALFUNCTIONS

   (a) Sprockets and shaft are not turning at the same speed: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
   WHY: a slipping sprocket will quickly wear its bearing surface on the shaft.

   (b) Sprocket is turning, chain jumping and is not staying engaged with same teeth: seen and/or heard by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
   WHY: the chain is slipping over the sprocket teeth and will soon cause excessive wear to both.

   (c) Shaft moves laterally in end bearings: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: estimate the apparent amount of the movement and enter in plant daily log. Notify supervisor. Refer to corrective maintenance.

   (d) Sprocket teeth are missing: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
   WHY: broken teeth will cause the chain to slip, twist, or bind. Prevent further teeth from breaking.

Continued

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Cracked or missing teeth: seen by operator.
       ACT: refer to corrective maintenance.

   (b) Teeth running below top of chain (excessive wear on teeth): seen by operator.
       ACT: refer to corrective maintenance.
       WHY: worn teeth may break off or cause the chain to slip or jam.

   (c) Chain not perpendicular to shaft (sprocket has slipped horizontally on shaft): seen by operator.
       ACT: refer to corrective maintenance.
       WHY: incorrect alignment may cause the chain to slip or jump off the sprocket.
   GEN ACT:
   (a) Take barscreen out of service by following SHUT-DOWN PROCEDURE FOR PROCESS except for motor.

   (b) Turn motor to HAND.

   (c) Inspect lower sprockets and shaft for preceding conditions in indicated manner while motor is still turning them.

   (d) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
       WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (e) Brace sprockets as indicated by plant developed operational manual.

   (f) Inspect for preceding conditions in indicated manner and perform maintenance if necessary. Unbrace sprockets.

   (g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

   (h) Enter all preventive maintenance on equipment record card.
       WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (1) Manually turn motor control switch to OFF, padlock electrical power supply in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
       WHY: to prevent accidental start-up that could cause injury to personnel.

   (2) Brace sprockets as indicated by plant developed operational manual.
       WHY: because of tension in the chains, sprockets may turn by themselves when set screws are loosened resulting in loss of fingers to operator.

RAKE CHAINS

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: no more than 2 estimated inches sag, no breaks in chains.
   ACT: operator looks at chains.

2. POSSIBLE MALFUNCTIONS

   (a) Too slack (more than 2 estimated inches sag): seen by operator.
   REF: barscreen manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance for adjustment.
   WHY: if chains are too slack, damage may occur to chains or sprockets causing expensive repairs and/or downtime.

   (b) Broken or cracked chain: seen by operator.
   REF: barscreen manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to rake drive motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: barscreen manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Chain showing signs of wear (links' diameters estimated 1/4 of original diameter): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: to allow scheduled maintenance and avoid unexpected breakdown.

   (b) Links or link pins broken or cracked: seen by operator.
   ACT: refer to corrective maintenance.

   (c) Chain riding up on teeth of sprocket causing excessive wear of teeth leading to chain jumping teeth on sprocket: seen by operator.
   ACT: refer to corrective maintenance for adjustment of chain tension and possible repair of sprocket.
   WHY: to allow for scheduled maintenance to prevent unexpected breakdowns.

   (d) Rakes binding (chains out of adjustment): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: to prevent extensive damage to the unit.

   GEN ACT:
   (a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Hose chains down using high pressure hose.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Lubricate chains as indicated in manufacturer's maintenance manual.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn rake drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn rake drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on component.
WHY: to prevent accidental start-up that could cause loss of fingers by operator or other serious injury.

RAKES

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: rake moving evenly and smoothly.
ACT: if rake not moving, activate component manually by turning control switch HAND. Operator notes that the rake is moving evenly and smoothly and is perpendicular to the bars.

2. POSSIBLE MALFUNCTIONS

(a) Rake not moving when control switch is on HAND: seen by operator.
REF: barscreen manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to rake drive motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Rake not perpendicular to bars and rakes are binding: seen by operator.
REF: barscreen manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to rake drive motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

RAKE WIPER

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: rake wiper is in position to wipe off the next rake coming up and is resting on stops; counter balances are on position marks on balance arms; wiper and wiper arm are clear of mats of entangled screenings.
ACT:
(a) Operator inspects for preceding conditions by visual observation.
WHY: a wiper has to be in position to wipe the rake clean or screenings will be deposited on the downstream side of the barscreens.

(b) The operator removes mats of entangled screenings on the wiper or wiper arm with a rake and places the screening in designated place.
WHY: a mat of screenings will hold the wiper off the stops.

2. POSSIBLE MALFUNCTIONS

(a) The wiper is not resting on the stops: seen by operator.
REF: manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: a wiper that is not properly positioned won't wipe the rake clean.

(b) The counter balance weights have slipped from their original place along the balance arms: seen by operator.
REF: manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: an unbalanced wiper may jam, or not rest on the stops.

3. PREVENTIVE MAINTENANCE
REF: manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Verify by visual observation that wipers are resting on the stops before performing any work on the component. If wipers are not resting on the stops refer to corrective maintenance.
WHY: wiper could fall if not resting on the stops and cause damage to equipment.

(c) Remove shock snubbers with wrench and test them for proper action as indicated by manufacturer's maintenance manual. Replace snubbers with new ones if they do not have the proper action.

(d) Grease the wiper pivot pins with grease gun.

(e) Check all set screws for tightness by attempting to tighten them with a screwdriver.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Look to see that wipers are resting on the stops before performing any work on the unit.
WHY: wiper could fall if not resting on the stops and crush operator.

RAKE SPRAYS

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: sprays on while screen is in operation; velocity and pattern of sprays are proper (pattern is full, no dribbling or uneven pattern, spray heads are open).
   ACT: operator inspects sprays by visual observation for preceding conditions. If spray head is plugged up, operator turns water control valve to OFF and sticks small diameter wire up head to remove blockage.
   WHY: too large a pattern and/or too small a velocity won't remove screenings, too small a pattern and/or too large a velocity will saturate equipment with spray causing rust.

2. POSSIBLE MALFUNCTIONS

   (a) Control solenoid not stopping or not starting spray water (operator pushes control switch and does not hear solenoid move or see spray water change condition): seen and heard by operator.
   REF: barscreen manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: barscreen manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:
   (a) Cut water to sprays by turning control valve to OFF.
   (b) Remove cap from end of pipe opposite to end where supply line connects.
   (c) Turn supply valve to ON and allow water to pour out of open end for 10 seconds. (Prevent water from splashing on face or exposed skin.)
   WHY: flushing water will carry material build-ups out of sprays' pipe.
   (d) Replace cap and turn control valve to ON.
   (e) Verify by visual observation that spray heads are open (full even pattern, no dribbling). If spray heads are not open, turn control valve to OFF and insert small diameter wire into head to remove blockage. Turn control valve to ON.
   (f) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Do not allow spray process water to splash on face or any exposed skin.
   WHY: danger of infection is always present in process water.

SCREENINGS SLUICEWAY AND FLUSHING WATER VALVE

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: sluiceway water flowing freely; no sand or sludge on edges of sluiceway.
   ACT: operator looks to see that sluiceway water is flowing freely and sluiceway is clean. If sand and/or sludge are on edges of sluiceway, operator hoses edges with high pressure hose.
   WHY: blockage could cause flooding; clean conditions can prevent concrete deterioration and an odor nuisance.

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
   REF: plant developed operational manual.
   FREQ: semi-annually.
   COND:
   (a) Flushing water valve in need of lubrication (valve sticking and not turning smoothly): operator tries to turn valve.
   ACT: apply grease called for in manufacturer's maintenance manual with small stick to valve stem. Turn valve while applying grease and distribute to all parts of stem.
   GEN ACT:
   (a) Take component off line by following SHUT DOWN procedure.
   (b) Inspect for preceding condition and perform maintenance if necessary.
   (c) Enter (exit) sluiceway using sound ladder.
   (d) Clean away sand and sludge by using high pressure hose.
   (e) Visually inspect for concrete spoilage; notify supervisor if spoilage is found.
   (f) Put unit back on line by following START-UP procedure.
   (g) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Use sound ladder while entering (exiting) sluiceway.
   WHY: to prevent injury or death of operator due to collapse of ladder.

   (b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent accidental start-up that could cause injury to personnel.

BAR RACK

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: the bar rack is being cleaned by the bar rakes; the flow through the bar rack has less than an estimated six-inch differential up and down stream of rack; the upstream side of the bar rack is free from blocks of wood or other large debris; the rake teeth mesh evenly and freely with the bar slots.
ACT: operator verifies by visual observation the preceeding conditions. If flow through bar rack has more than an estimated six inch differential, operator turns rake control to HAND until bar rack is cleared and then reads indicator of air flow to bubbler control to insure free flow necessary for proper automatic functioning of rakes. If air flow is not free, refer to corrective maintenance. Operator removes large debris from flow with hoe or rake.
WHY: if the bar rack is not kept clear, the sewage will back up in front of the rack and cause flooding conditions.

2. POSSIBLE MALFUNCTIONS

(a) The rake teeth don't mesh evenly and smoothly with the bar rack slots: seen by operator.
REF: barscreen manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: the rake may be out of alignment, or some submerged foreign object may be forcing the rake to one side which will cause rakes not to clean bar rack and allow large objects to pass which could cause serious equipment damage downstream.

(b) Bars are bent, broken or missing: seen by operator.
REF: manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning motor control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: bent bars will shear off rake teeth and missing bars will allow large objects to pass which could cause serious equipment damage downstream.

3. PREVENTIVE MAINTENANCE
REF: barscreen manufacturer's maintenance manual.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Take barscreen off line by following SHUT-DOWN PROCEDURE. (Use mechanical gates which are placed in position with overhead crane instead of power operated gates to isolate channel.)

Continued

Bar Rack--Continued

(b) Enter (exit) channel using sound ladder.

(c) Clean rocks and grit from barscreen channels with buckets and shovels.

(d) Clean tar, grease accumulation and rag mats from racks by using hand scrappers.

(e) Put barscreen on line by following START-UP PROCEDURE.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent accidental start-up that could cause injury to personnel.

(b) Mechanical gates which are placed in position with overhead crane should be used instead of power operated gates to isolate channel.
WHY: power operated gates such as plant influent gates might be opened accidentally causing injury to operator.

(c) Use sound ladder while entering (exiting) channel.
WHY: to prevent death or injury to operator due to collapse of ladder.

DRAIN VALVES (Gate Valves)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: valve is closed.
   ACT: operator observes valve handle position to see that valve is closed; reaches up and manually verifies it is closed.

2. POSSIBLE MALFUNCTIONS

   (a) Gate valve inoperable: operator tries to turn valve.
       REF: plant design print book.
       IMM OP ADJ: notify supervisor.

   (b) Gate valve binding (difficult to operate): operator tries to turn valve.
       REF: plant design print book.
       IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: plant developed operational manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Manually operate valve, lubricate shaft with proper lubricant as designated by plant manual, grease fittings with grease gun (preferably while stem is turning).
   (b) Hose out gate guides with high pressure hose.
   (c) Manually open and/or close valve.
       WHY: to determine by observation that the valve operates smoothly, without binding and seats properly when closed.
   (d) Enter all preventive maintenance on equipment record card.
       WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

BUBBLER TUBES

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: air flow at preset rate through rotometer (same instrument as flow meter which is composed of tube with floating indicator in column; ball changes position in column as amount of air flow changes).
ACT: operator observes reading of rotometer; operator purges bubbler tube as follows:
(a) manually remove spacer.
(b) depress purge control switch fully for 10 seconds.
(c) release to detent position (neutral position) for 15 seconds.
(d) pull to normal position as indicated by plant developed operational manual and replace spacer.
WHY: tube is purged to maintain bubbler tube free flow of air and control operational.

2. POSSIBLE MALFUNCTIONS

(a) Floating indicator at neutral position (no air flow through rotameter): seen by operator.
REF: plant maintenance guide.
IMM OP ADJ: notify supervisor.

(b) Indicator float below normal setting location: seen by operator.
REF: plant maintenance guide.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

TIMERS

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: timers run in normal sequence indicated by previous experience to control the running time of the screens, and screerings grinders. The screens and screenings grinders run at the same time, and the grinders run about 3 minutes after the screens stop.
ACT: the operator observes the preceding conditions.
WHY: the screenings grinders run for an interval after the screens stop to finish grinding up the last rags brought up by the screen rakes.

2. POSSIBLE MALFUNCTIONS

(a) The screens and the grinders do not run in the proper sequence as indicated by previous experience: seen by operator.
REF: manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: if the rags are not ground as the rakes bring the screenings up, a pile-up of screenings will occur.

(b) The timers will not start the screens, or the grinders: seen by operator.
REF: manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: manufacturer's maintenance manual
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Using a stop watch or electrical time standard, time the running period of each time to see of the timer dial agrees with the actual elapsed time. If it doesn't agree, refer to corrective maintenance.

(b) Manually turn the screen and grinder motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(c) Clean the timer electrical switch contacts with fine emery cloth.

Continued

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn screen and grinder motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn screen and grinder motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

RAKE POSITIONING SWITCH

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: position switch stops the rakes after the timer has timed out. The position switch stops the rakes in the proper position as indicated by plant developed operational manual; the trip arm on the position switch is actuated by each rake that passes by it. (The trigger arm kicks the control in OFF cycle; condition is such that when one rake comes up, it is not sitting in flow.)
   ACT: operator observes above characteristics.
   WHY: the rakes have to be stopped along their line of travel so that a rake isn't left sitting in the wastestream flow allowing floating material to hang up on it.

2. POSSIBLE MALFUNCTIONS

   (a) The position switch does not stop the rakes, and the trip arm is being moved by the rakes: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) The trip arm is not being moved by the rakes: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
   WHY: if the position switch is not activated, the rakes will run continuously.

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND:
   (a) Worn (diameter down .05" or more) or loose (wobbling) roller on trip arm: seen by operator.
   ACT: replace roller or arm as needed as indicated by maintenance manual.
   WHY: a worn or loose roller might catch on a rake and damage the position switch.
   GEN ACT:
   (a) Manually turn rake motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

Continued

(c) Grease the roller shaft with proper lubricant as designated by manufacturer's maintenance manual.

(d) Use a screwdriver to manually determine whether the adjusting and mounting screws are tight.

(e) Clean the switch contacts with fine emery cloth.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn rake motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Lock out the drive motor power (rake) before working on the position switch.
WHY: the unit may start up automatically causing injury to the operator.

(b) Manually turn off control power before cleaning the switch contacts.
WHY: to avoid the danger of electric shock.

REMOTE READOUTS AND INDICATORS

1. NORMAL PROCEDURE
   FREQ: at least once every hour.
   COND: indicating lights show actual status (ON, OFF, AUTO) of screen; screen ON (OFF, AUTO) and indicating light shows ON (OFF, AUTO). Water level indicators show actual differential across screen (indicator shows same height of difference in levels of water as measured by stick).
   ACT: operator visually inspects lights to determine whether the indication shows the actual condition of the screen and water level (looks at movement of screen and measures water level with stick).

2. POSSIBLE MALFUNCTIONS

   (a) Test button indicates lights burned out: seen by operator.
   REF: instrumentation design manual.
   IMM OP ADJ: refer to corrective maintenance.

   (b) Lights not indicating true status of equipment [lights ON (OFF), equipment OFF (ON)]: seen by operator.
   REF: instrumentation design manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (c) Differential indicators not indicating actual levels (actual level of differential of waters on both sides of screen different from reading on gage): seen by operator.
   REF: instrumentation design manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance for calibration.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

MOTOR (Grinder Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range given on plate, motor running with low even hum, shaft turning, and bearings temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is OFF) and makes the following observations: listens for unusual sounds, feels motor and bearings for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Scorched paint and black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: turn off power to motor by turning control switch to OFF. Notivy supervisor and refer to corrective maintenance.

   (d) Motor smoking: seen or smelt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (e) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(f) Unusual noise: heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: tighten motor mounts bolts with wrench.
WHY: loose motor mounts will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint or black stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage (greater than that stamped on name plate), refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

GEN ACT:

(a) Manually turn motor (grinder drive) control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Use safety ladders and harness if motor is located at unreachable height.

(d) Tighten end plate bolts with wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

(e) Use grease gun to apply proper amount and type of lubricant as called for in manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(g) Manually turn motor (grinder drive) control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn motor (grinder drive) control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located at unreachable height.
WHY: to prevent falls and resulting injury.

COUPLING (Grinder)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: coupling running smoothly and quietly; motor, drive and pump are in straight line and connecting bolts are intact.
   ACT: operator listens for unusual sounds when component is running and looks at coupling bolts and alignment when component is not running; looks for vibrations while running.

2. POSSIBLE MALFUNCTIONS

   (a) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: quarterly.
   COND: none.
   GEN ACT:
   (a) Manually turn secondary sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Use grease gun to lubricate coupling with proper type and quantity of lubricant as called for in manufacturer's maintenance manual.

   (c) Wipe up all spilled lubricant with rags and/or absorbent.
   WHY: to prevent fire hazard due to accumulation of dust and material.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

Continued

(b) Wipe up all spilled lubricant with rags and/or absorbent.
WHY: to prevent slippery conditions and possible falls.

GRINDER

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: no unusual sounds, no water leaks.
ACT: operator starts grinder by turning control switch to HAND if component is not running. Operator listens for unusual sounds as determined by previous experience, observes grinder for leaks. Operator then returns control switch to AUTO.

2. POSSIBLE MALFUNCTIONS

(a) Unusual sounds in grinder (as if metal objects were inside): heard by operator.
REF: grinder manufacturer's manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Grinder reverses more than normal in a short period of time (does not make a complete sweep within several revolutions): seen by operator.
REF: grinder manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: grinder manufacturer's maintenance manual.
FREQ: at least twice weekly.
COND: none.
GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Close inlet and discharge valves manually.

(c) Drain grinder of water by using drain valve.

(d) Remove access hatch by turning bolt with wrench to release clamp.

(e) Remove excess material manually and examine cutting edge for chipped teeth.

(f) Refer to corrective maintenance if teeth are damaged.

(g) Adjust cutting edges using gage and adjusting screw if not damaged.
WHY: dull or damaged cutting teeth will cause clogging and result in excessive down time.

Continued

(h) If taken apart for repairs, reassemble and replace access hatch by turning bolt with wrench to tighten clamp.

(i) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Manually close with handle and tag all inlet and discharge valves to grinder before opening the unit.
WHY: major flooding could occur causing drowning of operator.

GRINDER SUMP

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: grinder sump is collected near a fixed level by the screenings flushing water valve. The grinder sump level is within normal (not overflowing, cannot see bottom) limits; there are no large floating objects or rag mats in the sump, the rags are being sucked down and ground up.
ACT: operator visually observes the above characterisitcs.
WHY: the grinders have to grind the screenings as they come into the grinder sump or a jam-up of screenings will occur.

2. POSSIBLE MALFUNCTIONS

(a) The grinder sump is empty of water, and tne grinders are running: seen by operator.
REF: plant developed operations manual.
IMM OP ADJ: look at flushing water supply valve. If it is closed, manually turn off the screens and grinder. If it is open and not getting water flow, manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: the grinders need flushing water to be able to grind rags and discharge the slurry.

3. PREVENTIVE MAINTENANCE
REF: manufacturer's maintenance manual.
FREQ: once daily.
COND: none.
GEN ACT:

(a) Manually turn grinder motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Probe bottom of grinder sump with a long handled hoe.
WHY: to see if there is an accumulation of rocks, or a large foreign object in the bottom of the grinder sump.

(c) If there is an accumulation of rocks, or a large foreign object in the bottom of the grinder sump, lift gratings up manually and rope off dangerous area. If there is no accumulation of foreign objects, proceed with start-up of unit.

Continued

(d) To remove matter in the bottom of the sump:
   (1) drain the sump by manually opening drain valve.
   (2) manually close valve after sump is drained.
   (3) manually remove the sunken foreign matter using screen attached to pole.

   WHY: if debris is allowed to accumulate in the bottom of the sump, eventually the grinders will suck it into the inlet pipe, causing the grinders to jam.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn grinder motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(f) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Lock out screens and grinders when working in sump. WHY: the system may start up automatically and the flushing water would rush into the grinder sump flooding it in a very short time and possibly drowning the operator.

(b) Rope off around the grinder sump when the gratings are up. WHY: someone might accidentally fall into the open hole.

GRINDINGS RETURN SLUICEWAY

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: grindings flowing freely to influent; free flow of normal sluiceway water; free of scum or debris buildup; material returning through proper sluice gate as designated by plant log book to influent flow if more than one barscreen is in operation.
   ACT: operator observes preceding characteristics. By using high pressure hose, hoses down sluiceway and immediate area to remove any hang up or splashed out grindings.

2. POSSIBLE MALFUNCTIONS

   (a) Snags in channel allowing buildup of grindings: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

   (b) Grinder teeth worn or broken (grindings tend to string together more than usual): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

PIPING

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: no visible spurting leaks; possible film or drip of water on pipe; pipe supports are solid.
ACT: operator looks at all pipes and fittings for above conditions; operator visually inspects supports.

2. POSSIBLE MALFUNCTIONS

   (a) Major leak (stream of water): seen by operator.
   REF: plant developed maintenance manual.
   IMM OP ADJ: alter valve arrangement to by-pass leak or manually shut down equipment related to leaky pipe. Manually close valves to isolate leak and start alternate units. Start sump pumps up, verify by observation that the drainage sump pumps are sucking up water from the leak. Notify supervisor and refer to corrective maintenance. If pumps are not sucking up water, refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: plant developed maintenance manual.
FREQ: annually.
COND:
   (a) Minor leaks (dripping) of water: seen by operator.
   ACT: repair by tightening joints that leak. Patch leaks along joint of pipe with material specified in plant developed maintenance manual.

   (b) Cracks in expansion joints: seen by operator.
   ACT: refer to corrective maintenance for replacement.

   GEN ACT:
   (a) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (b) Remove cracked and peeling paint and rust with wire brush.

   (c) Repaint with proper kind and color of paint as designated in plant developed maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

VALVES

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: valves that should be open are open, valves that should be closed are closed (valve positions to be obtained from supervisor).
ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

(a) Handle frozen: felt by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Broken stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(c) Leaking around stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(d) Valve turns hard: felt by operator.
REF: valve manufacturer's maintenance manual.
IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: valve manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:

(a) Wipe old grease from valve stem with rags.

(b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.

(c) Move valve through one complete cycle (completely open, then completely closed); if it does not completely open (close) refer to corrective maintenance.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRST AID KIT

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed on inventory sheet in kit.
ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies; also notes location of kit.
WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

(a) Kit is missing: seen by operator.
REF: none.
IMM OP ADJ: notify supervisor.

(b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
REF: first aid kit manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: first aid kit.
FREQ: at least once every week.
COND:
(a) Some supplies missing: seen by operator.
ACT: determine actual amount of supplies missing
GEN ACT:
(a) Replenish first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.
(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshal.
   ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
   WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

   (a) Equipment missing: seen by operator.
   REF: none.
   IMM OP ADJ: notify supervisor.

   (b) Equipment damaged: seen by operator.
   REF: fire fighting equipment maintenance manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: fire fighting maintenance manual.
   FREQ: annually.
   COND:
   (a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
   ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
   GEN ACT:
   (a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
   WHY: low weight indicates extinguisher should be recharged.

   (b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is not low.

   (c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

GRIT REMOVAL

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
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U. S. Environmental Protection Agency
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GRIT REMOVAL

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START-UP PROCEDURE FOR PROCESS

1. Look at bucket drive motor and blower motor control switches to see that they are in the OFF position; put in OFF if necessary.
   WHY: to start up any process, all motors and equipment should be off in order to perform the start-up sequence properly.

2. Remove red LOCK-OUT-TAG, unlock electrical power supply switch.

3. Verify that the bucket drive motor, speed reducer, gear box, chains, buckets, and sprockets are functioning normally as indicated by previous experience as follows:
   (a) Manually start motor by turning control switch to ON.
   (b) Verify by visual observation that bucket drive motor, speed reducer shaft, sprocket shaft, bucket chain are moving normally (indicated by previous experience) and that no unusual sounds (indicated by previous experience) are produced by the motor and speed reducer. *If any component is not functioning properly, refer to corrective maintenance for repair before proceeding.*
   (c) Manually stop bucket drive motor by turning control switch to OFF.
   WHY: components needing repairs should be determined and repairs made before tank is filled.

4. Verify that drain is closed by observing that valve is CLOSED.

5. Put diffusers into tank as follows:
   (a) Remove pin in hole at top of air header pipe.
   (b) Lower diffusers into tank.
   (c) Release lifting cable to air header and raise cable back up.
   (d) Unfasten anchors which are anchoring the lifting machine in place.
   (e) Remove lifting machine from lifting position and store as specified by plant routine.

6. Open sluice gate by moving operating wheel (handle) to OPEN position. Look at gate to see that influent is entering basin. *If gate does not operate properly, refer to corrective maintenance for repair.*

7. When the tank is approximately half full, start the blower motor as follows:
   (a) Manually start blower motor by turning control switch to ON.
   (b) Verify by visual observation that blower motor and air blower are operating normally [no unusual sounds (indicated by previous experience) are being produced and the pressure gage is showing the correct pressure (determined by limits on motor); air is being delivered to the diffusers (liquid in tank is being agitated).]
   If any component is not functioning properly, refer to corrective maintenance for repair.

Continued

8. When the influent level in basin is an estimated one foot below discharge weir, start the grit collector system as follows:
   (a) Start bucket drive motor by turning control switch to ON.
   (b) Verify by visual observation that bucket drive motor, speed reducer shaft, sprocket shaft, chains and buckets are moving properly (determined by previous experience) and that no unusual sounds (indicated by previous experience) are produced by the motor and speed reducer.

If any component is not functioning properly, refer to corrective maintenance for repair.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Manually close sluice gate by moving operational wheel (handle) to CLOSED position. Look at gate to insure that influent has stopped entering basin. *If influent has not stopped entering basin, refer to corrective maintenance.*

2. Draw all grit from basin to receiving hopper with grit collector buckets by turning bucket drive motor control switch to ON.

3. When all grit has been collected (buckets are dumping empty), turn bucket drive operational switch to OFF.

4. Manually turn blower motor control switch to OFF.

5. Padlock electrical power supply in OFF position and place red LOCK-OUT-TAG on power box for switch.

6. Manually open drain by turning drain valve operating wheel (handle) to OPEN.

7. As liquid level drops, use high pressure hose to wash down walls, chains, and all exposed components.
   WHY: if components are not hosed down as they are exposed, solids that adhere (stick) will dry and begin to cause odor problems. Solids that have dried are difficult to remove.

8. Lift diffusers from tank as follows:
   (a) Place lifting machine in proper position to raise diffusers (as indicated by previous experience).
   (b) Anchor lifting machine securely in place by anchors provided.
   (c) Attach lifting cable to air header and raise diffusers from tank.
   (d) Secure raised diffuser by inserting pin in hole at top of air header pipe.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

Component/Step	Frequency
1. Tank (Grit Chamber)	every 8 hours
2. Blower	" " "
3. Motor (Blower)	" " "
4. Coupling (Blower Motor, Bucket Drive Motor)	" " "
5. Pressure Indicating Device (Gage, Manometer)	" " "
6. Air Pressure Relief	" " "
7. Motor (Bucket Drive)	" " "
8. Belts	" " "
9. Speed Reducer (Bucket Drive)	every 4 hours
10. Gear Box	every 8 hours
11. Sprockets	" " "
12. Chains	every hour
13. Buckets	every 2 hours
14. Shafts	every 8 hours
15. Shaft Bearings	" " "
16. Receiving Hopper	every ½ hour
17. Sluice Gates	every 4 hours
18. Baffles	" " "
19. Weirs	every 8 hours
20. Valves	" " "
21. Electrical Switches	" " "
22. Manifold	" " "
23. Piping	" " "
24. Shoes	" " "
25. Diffusers	every 4 hours
26. Influent Sampling	every 2 hours
27. Grit Sample	every hour
28. Fire Fighting Equipment	every 8 hours
29. First Aid Kit	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

Component/Step	Frequency
1. Motor (Bucket Drive)	monthly
2. Motor (Blower)	"
3. Gear Box	semi-annually
4. Sprockets	weekly
5. Chains	"
6. Guide Rails	semi-annually
7. Shoes	semi-annually
8. Sluice Gate	weekly/annually
9. Speed Reducer (Bucket Drive)	weekly/semi-annually
10. Valves	monthly
11. Piping	annually
12. Blower	weekly
13. Diffusers	monthly
14. Baffles	annually
15. Belts	weekly
16. Weirs	annually
17. Buckets	semi-annually
18. Air Pressure Relief	" "
19. Air Cleaner	" "
20. Coupling	monthly
21. Receiving Hopper	annually
22. Tank (Grit Chamber)	semi-annually
23. First Aid Kit	weekly
24. Fire Fighting Equipment	annually
25. Manifold	"
26. Shaft Bearings	semi-annually

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Color

    (a) Black: seen by operator.
    CAUSE:
    (1) Waste has turned septic because of:
        a. low flow in collection system.
        b. its high temperature.
        c. extended stay in collection system.
        d. shock load of toxic materials introduced into collection system.

    (b) Any color not normal for a particular plant (determined by entries of abnormalities in plant operations log): seen by operator.
    CAUSE: unusual industrial waste being introduced into collection system.

2. Odor

    (a) Scent like rotten eggs: smelled by operator.
    CAUSE:
    (1) Waste has turned septic, thereby generating H_2S because of:
        a. low flow in collection system.
        b. its high temperature.
        c. extended stay in collection system.
        d. shock load of toxic materials introduced into collection system.
        e. solids concentration too high.
        f. septic floatage on surface.

    (b) Scent like petroleum products: smelled by operator.
    CAUSE: dumping of petroleum products (gas, oil, kerosene, etc.) by industry and business (service stations, etc.).

    (c) Scent like bleach: smelled by operator.
    CAUSE: excessive prechlorination.

3. Rate of Flow

    (a) High (level of effluent is at top of the weir): seen by operator.
    CAUSE:
    (1) Too much infiltration into collection system.
    (2) Shock load caused by industries dumping unusual volume of waste.

Continued

Abnormals and Probable Causes for Process--Continued

(b) Low (no flow over weirs): seen by operator.
CAUSE:
(1) Stopped up collection lines.
(2) Too much exfiltration from collection system.

4. Agitating Velocity

(a) Velocity of agitation too slow (tank surface shows a slow easy roll across entire surface area): seen by operator.
CAUSE:
(1) Rate at which grit is being removed has been decreased.
(2) Rate at which grit is being introduced into basin has increased.
(3) Diffusers have not been cleaned.
(4) Blower is not delivering proper amount of air.
(5) Air adjustment on diffusers has been changed.

(b) Velocity of agiation too fast:(tank surface choppy--not a slow even roll across entire surface area): seen by operator.
CAUSE:
(1) Blower delivering too much air.
(2) Motor speed has been increased.
(3) Air control on diffusers has been changed.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Composite--influent

FREQ: one sample each 8-hour shift (each sample consisting of at least 4 parts; one part every 2 hours or less).
ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream enters the plant. When dipping sample do not touch channel sidewalls and do not include large chunks of material in sample. Pour sample into a clean container, cap, and immediately place in laboratory refrigerator.
WHY: large solids or material scraped from the sidewall will not give a representative sample of the influent.

The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, influent composite sample for 8:00 a.m.--4:00 p.m. shift would be as follows:

Time Taken	Flow Rate, MGD	Volume of Sample, *mℓ*
10:00 a.m.	7.0	700
12:00 N	6.5	650
2:00 p.m.	6.0	600
4:00 p.m.	5.5	550
	Total Shift Sample	2500 *mℓ*

In the above example, 100 *mℓ* of sample were taken for each 1 MGD flow rate. Determination of this sample volume to flow rate ratio is as follows:

(a) Obtain from laboratory the total volume of sample needed to conduct tests for 24-hour period (assume 6 ℓ/day)

(b) Determine the number of samples to be taken in a 24-hour period (assume one every two hours)

$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed (from part (a) above) by the number of samples to be taken (from part (b) above) to obtain the *average* volume needed for each sample:

$$\frac{6 \ \ell}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5 \ \ell}{\text{sample}}$$

(d) Divide the average volume per sample (from part (c) above) by the average daily flow of wastewater through the plant (assume 5 MGD)

$$\frac{0.5 \ \ell}{\text{sample}} \times \frac{1}{5 \text{ MGD}} = \frac{0.1 \ \ell/\text{sample}}{1 \text{ MGD}}$$

Continued

Normal Sampling--Continued

(e) Multiply the sample volume per 1 MGD (from part (d) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD):

$$10{:}00 \text{ a.m. sample} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}} \times 7.0\ \text{MGD} = 0.70\ \ell = 700\ m\ell$$

WHY: a composite sample will give a more accurate representation than a grab sample because the wastestream characteristics are continually changing as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed

2. Grab--Grit Sample

FREQ: one sample during time grit collection system is operating.
ACT: using a clean dipper, place dipper between discharge chute and receiving hopper--collection 100 mℓ of sample (dipper should be marked at 100 mℓ or should be full at 100 mℓ). Pour sample into clean container and place in laboratory (obtain from laboratory the total volume of sample needed).

MAJOR SAFETY FACTORS

1. Prevent splashing of sewage into the eyes or other body openings.
WHY: pathogenic organisms that abound in sewage water can cause infection to the operator.

2. Wash the hands after taking sewage samples.
WHY: organisms can be introduced into the body by careless sanitary practices thus causing possible sickness.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTOR (Blower)

1. NORMAL PROCEDURE
FREQ: at least once every hour
COND: motor only warm (motor temperature within range on name plate), running with even hum, free of vibration, shaft turning, bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
ACT: operator turns control switch to ON (if component is OFF) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat.

2. POSSIBLE MALFUNCTIONS

(a) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Motor stopped (shaft not turning): seen by operator.
REF: blower motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(c) Excessive vibration: seen or felt by operator.
REF: blower motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(d) Unusual noise: heard by operator.
REF: blower motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(e) Scorched paint or black stains on motor housing: seen by operator.
REF: blower motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

(f) Smoke rising out of casing: seen and/or smelt by operator.
REF: blower motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connections could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn blower motor control switch to OFF, padlock electrical power supply switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Tighten end plate bolts with wrench.
WHY: loose bolts will permit the motor to become misaligned.

(d) Use grease gun to apply proper amount of the correct lubricant and proper amount as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

(e) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled and excess lubricant with rags and/or absorbent.
WHY: lubricant will produce the danger of a slippery working area, resulting in falls and bodily injury to operator.

BLOWER

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: blower running smoothly, no vibration, pressure indicating dial shows pressure within range called for by plant operational manual, and no excessive heat build up (operator can hold hand firmly on blower for at least 30 seconds).
ACT: operator reads pressure indicating dial and feels blower.

2. POSSIBLE MALFUNCTIONS

(a) No air flow: seen by operator.
REF: blower manufacturer's maintenance manual.
IMM OP ADJ: cut power to blower by manually turning blower control switchto OFF. (If bucket drive motor is ON, manually turn bucket drive motor control switch to OFF.)

(b) Low capacity air flow (discharge pressure indicating dial showing less pressure than manufacturer's recommended operating pressure): seen by operator.
REF: blower manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower by turning blower motor control switch to OFF. (If bucket drive motor is ON, manually turn bucket drive motor control switch to OFF.)

(c) Overheating of bearing or gears (operator cannot hold his hand on blower casing adjacent to bearings or gears for 30 seconds): felt by operator.
REF: blower manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower by manually turning blower motor control switch to OFF. (If bucket drive motor is ON, manually turn bucket drive motor control switch to OFF.) Refer to corrective maintenance.

(d) Excessive vibration (a slight movement between blower and base it is resting on): seen or felt by operator.
REF: blower manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to blower motor by turning blower motor control switch to OFF. (If bucket drive motor is ON, manually turn bucket drive motor control switch to OFF.) Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: blower manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Chipped or broken concrete around blower base: seen by operator.
ACT: tighten all blower mount bolts with wrench.
WHY: loose blower mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

Continued

(b) Higher than normal temperature (indicated on temperature gage): seen by operator.
ACT:
(1) Manually turn blower control switch to OFF.
(2) Verify by observation that air intake is not stopped up. (Clean by hand if necessary.)
(3) Verify by observation that diffusers are not stopped up. (Clean by hand if necessary.)
(4) Feel blower for "hot spots" (any spots on blower where operator cannot hold his hand for 30 seconds). If any are found, refer to corrective maintenance.
WHY: excess heat will damage blower, which will result in high repair cost and/or excessive down time.

GEN ACT:

(a) Manually turn blower control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Lubricate blower with amount and type of lubricant as indicated in manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings.

(d) Clean up all excessive or spilled lubricants with rags and/or absorbent.
WHY: lubrication will accumulate dirt and dust, thereby producing a fire hazard.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON(HAND) to verify component is operational. Turn switch to AUTO.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn blower control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting blower which could cause serious injury to operator.

(b) Clean up all spilled and excess lubricant with rags and/or absorbent.
WHY: lubricant will produce the danger of a slippery working area, which may result in injury to operator.

DIFFUSERS

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: wastestream is being vigorously agitated (pressure gage is showing changes in pressure): pressure level is within limits as indicated by plant developed operational manual.
ACT: operator looks at wastestream in grit basin and observes surface agitation; operator looks at pressure gage and observes pressure level.

2. POSSIBLE MALFUNCTIONS

   (a) Blower running but little or no agitation taking place in grit chamber: seen by operator.
   REF: diffuser manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: diffuser manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Put on protective clothing (rubber gloves, apron, life preserver).

   (c) Raise diffusers to maximum height by manually attaching lifting machine cable to air header pipe and raise diffusers by pumping hydraulic pump on machine; secure diffusers in place by manually placing safety pins through holes on top of header system.

   (d) Remove all drain plugs from diffusers with wrench.

   (e) Flush drains and hose off drain plugs with high pressure hose.

   (f) Remove all rags, strings, and other debris from diffusers with rake and place in proper container (indicated by plant operation manual).

   (g) Replace all drain plugs with wrench.

   (h) Remove safety pins from diffusers and lower diffusers back into tank with hoisting unit.

   (i) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

Diffusers--Continued

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Put on protective clothing (rubber gloves, apron, life preserver).
WHY: operator could fall into basin causing possibility of cuts and resulting infections from germ-ladened surfaces of diffusers.

MANIFOLD

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: no visible air leaks or no air leaks that can be heard by operator.
ACT: operator looks at manifold and fittings and listens for leaks.

2. POSSIBLE MALFUNCTIONS

(a) Minor air leak: heard by operator.
REF: plant developed maintenance manual.
IMM OP ADJ: none.

(b) Major air leak (steady drop in air pressure showing on air pressure gage): seen by operator.
REF: plant developed maintenance manual.
IMM OP ADJ: manually alter valve arrangement to bypass leak and immediately notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: plant developed maintenance manual.
FREQ: annually.
COND: none.
GEN ACT:
(a) Use wire brush to remove cracked, peeling paint, and rust.
(b) Repaint with proper type and color of paint.
(c) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

AIR PRESSURE RELIEF

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: air pressure relief discharging air smoothly without excessive noise, vibration, and temperature (higher than that stated by manufacturer's manual).
   ACT: operator listens for unusual sounds, feels unit for excess vibration and temperature.

2. POSSIBLE MALFUNCTIONS

   (a) Air pressure relief not discharging air: seen and/or heard by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Excessive temperature (gage shows temperature greater than that stated by manufacturer's manual for normal operation): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: pressure relief valve manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Isolate relief valve by turning input valve clockwise.

   (b) Inspect by visual observation for rust. If any rust is present, sand rust off with fine emery paper and repaint area with paint as indicated in manufacturer's maintenance manual.

   (c) Clean valve using rag and mild solvent.

   (d) Open input valve by turning it counter-clockwise.

Continued

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate time used to perform maintenance.

4. MAJOR SAFETY FACTORS--None

AIR CLEANER

1. NORMAL PROCEDURE--None

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
REF: air cleaner manufacturer's maintenance manual.
FREQ: semi-annually.
COND:
(a) Air cleaner clogged with debris: seen by operator.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before perfroming any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Remove air cleaner by hand and wash in solvent, hose down and dry with air hose.

(c) Manually replace air filter with new one if needed (if old one will not allow light to penetrate through it).

(d) Manually replace air cleaner.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND).

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

PIPING

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: no visible air leaks; no leaks that can be heard by operator.
ACT: operator looks at all piping and fittings that are visible and also listens for any leaks.

2. POSSIBLE MALFUNCTIONS

(a) Minor leak: seen and/or heard by operator.
REF: plant developed maintenance manual.
IMM OP ADJ: none.

(b) Major leak (steady pressure drop showing on pressure gage): seen by operator.
REF: plant developed maintenance manual.
IMM OP ADJ: manually alter valve arrangement to bypass leak and immediately notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: plant developed maintenance manual.
FREQ: annually.
COND: none.
GEN ACT:
(a) Follow shut-down procedure to drain tank.

(b) Use sound ladder to enter(exit) tank.

(c) Use wire brush to remove all chipped and peeling paint and rust.

(d) Repaint with proper type and color of paint.

(e) Follow start-up procedure to fill tank.

(f) Enter all preventive maintenance on equipment record card.

4. MAJOR SAFETY FACTORS

(a) Use sound ladder while entering(exiting) tank.
WHY: to prevent injury or death due to collapse of unsound ladder.

GEAR BOX

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: oil gage shows oil level within normal markings indicated on stick, gears making no unusual noise (determined by previous experience).
ACT: operator listens to gear box and looks at oil gage, adds proper oil as indicated by manufacutrer's maintenance manual if necessary. If oil is low, looks for leaks in gear box. If oil is seeping out (film), operator records leak and observes it for a period of time to determine the severity of leak.
WHY: improper oil or not enough may damage gear box components.

2. POSSIBLE MALFUNCTIONS

(a) Gears making unusual noise (indicated by previous experience): heard by operator.
REF: gear box manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, manually disengage clutch by moving clutch lever to NEUTRAL, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Oil leak (puddle): seen by operator.
REF: gear box manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, manually disengage clutch by moving clutch lever to NEUTRAL, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: gear box manufacturer's maintenance manual.
FREQ: semi-annually.
COND:
(a) Metal shavings found as old oil is drained from gear box: operator feels oil and looks for metal shavings.
ACT: refer to corrective maintenance for further inspection.
WHY: metal shavings in oil indicate worn gears.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually disengage clutch by moving clutch lever to NEUTRAL.

(c) Drain oil by removing oil drain plug with wrench and drain into container.

(d) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

Continued

Gear Box--Continued

(e) Replace plug with wrench.

(f) Replace correct amount of proper oil as indicated in manufacturer's maintenance manual.
WHY: too much, too little, or the wrong type of oil can cause damage to gear box components.

(g) Clean area of any oil spills with rags and/or oil absorbent.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) Engage clutch manually by moving clutch lever to ENGAGE.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment. Also disengage clutch.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up oil spills with rags and/or oil absorbent.
WHY: oil on walkways provide slippery surface on which an operator can lose his footing and fall, thus causing serious injury.

COUPLING (Blower Motor and Bucket Drive Motor)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: coupling turning freely and quietly with no vibration; motor, coupling and bucket drive in line; motor, coupling and blower in line; motor, drive are in straight line and connecting bolts are intact.
   ACT: operator listens for unusual noise as when component is running and looks at coupling bolts and alignment when component is not running; looks for vibrations and feels end plates for vibrations while running.

2. POSSIBLE MALFUNCTIONS

   (a) Coupling vibration: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Unusual noise (determined by previous experience): heard by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Manually remove motor guard.

   (c). Use grease gun to lubricate coupling with proper amount and type of grease as indicated in manufacturer's maintenance manual.

   (d) Clean up all lubricant spills with rags and/or absorbent.
   WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

Continued

(e) Manually replace motor guard.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Manually replace guard in correct sequence before starting motor.
WHY: to avoid possibility of operator becoming mangled by moving parts.

(c) Clean up all spilled and excess lubricant with rags and/or absorbent.
WHY: lubricant will provide the danger of a slippery working area, thus causing falls and/or injury to operator.

SPEED REDUCER (Bucket Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: oil level gage shows oil within normal levels marked on gage. No oil or grease on housing, gears running at normal noise level (indicated by previous experience). Heat is in normal range (no smell, smoke): possible minor leak (a few drops of oil on floor, a small puddle).
   ACT: operator visually observes quantity of oil on gage and in housing. Adds proper oil as indicated on name plate if necessary. Listens to gear sounds and observes any smoke or smell. If minor leak, record, wipe up, and observe over a period of time to determine urgency of repairs needed.
   WHY: low oil level will cause excessive wear on gears. Proper type of oil is necessary to long life and smooth operation.

2. POSSIBLE MALFUNCTIONS

   (a) Rattlings, thumping noises, or vibrations: heard by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor running, coupling between motor and reducer not turning: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Motor and coupling turning, speed reducer shaft not rotating: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (d) Major leak of oil (oil puddle under gear box and/or thick film of oil on housing): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENACE
REF: manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Static oil level below normal as indicated on gage stick: seen by operator.
ACT:
(1) Remove oil fill plug with wrench.
(2) Add proper amount of correct lubricant (plant operational log and name plate on speed reducer will give needed information).
(3) Replace oil fill plug with wrench.
GEN ACT:
(a) Manually turn speed reducer motor control switch to OFF.

(b) Inspect for low oil level by removing gage stick and reading level, perform maintenance if necessary.

(c) Manually turn control switch to ON.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Manually turn bucket drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment (gears, drive shaft, other parts of component).

(b) Replace oil as follows:

(1) Remove oil drain plug with wrench and drain old oil out completely into container.

(2) Flush with manufacturer's suggested flushing agent (if not designated, flush with new oil); allow to drain out completely.

(3) Replace oil drain plug with wrench and fill with proper type oil as indicated by manufacturer's maintenance manual.
WHY: to remove impurities with old oil and accumulated foreign matter; addition of proper type oil is necessary to long life of gears.

(c) Use grease gun to lubricate all bearings (refer to manufacturer's maintenance manual for location of bearings, type, and amount of grease).

(d) Clean area of oil spillage or leakage and lubricant spillage with rags and/or absorbent.
WHY: lubricant will collect dirt and dust and create fire hazard.

Continued

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean area of oil spillage or leakage with rags and/or absorbent.
WHY: reduces chances of operator slipping and falling.

MOTOR (Bucket Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: motor only warm, running with even hum, free of vibration, shaft turning; bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if component is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Bucket drive motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: bucket drive motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Bucket drive motor stopped (shaft not turning): seen by operator.
   REF: bucket drive motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: bucket drive motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (d) Unusual noise (determined by previous experience): heard by operator.
   REF: bucket drive motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: bucket drive motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: bucket drive motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: bucket drive motor manufacturer's maintenance manual.
FREQ: monthly
COND:

(a) Chipped or broken concrete around bucket drive motor base: seen by operator.
ACT: tighten all bucket drive motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of bucket drive motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connections could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn bucket drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Tighten end plate bolts with wrench.
WHY: loose bolts will permit the motor to become misaligned.

(d) Use grease gun to apply proper amount of the correct lubricant as indicated in the manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings.

Continued

Motor (Bucket Drive)--Continued

(e) Clean up all excessive or spilled lubricant with rags and/or absorbent. WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component. WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled and excess lubricant with rags and/or absorbent. WHY: lubricant will provide the danger of a slippery working area resulting in falls and bodily injury.

BUCKETS

1. NORMAL PROCEDURE
   FREQ: at least once every 2 hours when buckets are in operation.
   COND: buckets are moving freely (no objects clogging movement); moving at a constant rate; no loose buckets.
   ACT: operator looks at buckets, including chain to verify conditions above. Operator makes sure he looks at all the buckets during inspection.
   WHY:
   (a) Broken or loose buckets will cause damage to equipment resulting in expensive repairs and/or extensive down time.

   (b) Only a few of the buckets are visible at one time.

2. POSSIBLE MALFUNCTIONS

   (a) Buckets not moving: seen by operator.
   REF: bucket drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF position.

   (b) Broken bucket (cracked open): seen by operator.
   REF: bucket drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to bucket drive motor by turning control switch to OFF position.

3. PREVENTIVE MAINTENANCE
   REF: bucket drive manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND:
   (a) Broken (cracked) bucket: seen by operator.
   ACT:
   (1) Use proper size and type of wrench to remove bolts that mount bucket to chain.

   (2) Manually remove old bucket.

   (3) Use proper size and type of wrench to insert new bolts after replacing old bucket with new bucket.
   WHY: faulty buckets will not remove grit from grit chamber properly and will also cause damage to other equipment.

   (b) Loose bucket (rattles and jerks): seen and/or heard by operator.
   ACT: use proper size and type wrench to tighten bolts that mount bucket to chain. If bolt is missing, replace with new bolt.
   WHY: faulty buckets will not remove grit from grit chamber properly and will also cause damage to other equipment.
   GEN ACT:
   (a) Follow Steps 1 through 6 in SHUT-DOWN PROCEDURE to drain basin and clean off components.

   (b) Use clean and structurally sound ladder(s) to enter(exit) grit chamber.

Continued

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Follow START-UP PROCEDURE (omitting step #4) to put grit chamber back into operation.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Use clean and structurally sound ladder(s) when entering(exiting) grit chamber.
WHY: slippery or unstable ladders provide possibility that operator could fall into chamber causing possible injury or death.

SHOES

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: shoes are above the level of the flight (not worn down to level of flight).
   ACT: operator observes shoes as he inspects other components.

2. POSSIBLE MALFUNCTION--None

3. PREVENTIVE MAINTENANCE
   REF: bucket drive manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND:
   (a) Shoe(s) worn to level of the flights: seen by operator.
   ACT: replace worn shoe(s) as directed by the maintenance manual.
   GEN ACT:
   (a) Follow Steps 1 through 6 in SHUT-DOWN PROCEDURE to drain basin and clean off components.

   (b) Use clean and structurally sound ladder(s) to enter(exit) grit chamber.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Follow START-UP PROCEDURE (omitting Step 4) to put grit chamber back into operation.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
   WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

   (b) Use clean and structurally sound ladder(s) when entering(exiting) grit chambers.
   WHY: slippery or unstable ladders provide possibility that operator could fall into chamber causing possible injury or death.

SPROCKETS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: sprocket turning smoothly, no teeth missing; meshing with chain links.
   ACT: operator looks at sprocket turning and at each of its teeth.

2. POSSIBLE MALFUNCTIONS

   (a) Sprocket not turning: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Sprocket turning, chain not moving: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Teeth are missing: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Crack in tooth: seen by operator.
   ACT: refer to corrective maintenance.

   (b) Excessive wear of teeth (outer edge of teeth lie below top of chain when chain is fully engaged): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: worn teeth may cause chain to slip which will create major operational problems.

   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Tighten set screw in sprocket with proper wrench (screwdirver or allen wrench).
WHY: when a sprocket becomes loose, it can easily cause serious damage to shaft.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operationa. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

SHAFTS

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift (when bucket drive is operating).
COND: shaft turning smoothly, no vibrations, no abnormal sounds (indicated by previous experience).
ACT: operator looks at shafts turning and listens for abnormal sounds.

2. POSSIBLE MALFUNCTIONS

(a) Shaft not turning: seen by operator.
REF: bucket drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to bucket drive by turning control switch to OFF position.

(b) Shaft turning, buckets not moving: seen by operator.
REF: bucket drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to bucket drive by turning control switch to OFF position.

3. PREVENTIVE MAINTENANCE
REF: bucket drive manufacturer's maintenance manual.
FREQ: annually.
COND:
(a) Cracked or bent shaft: seen by operator.
ACT: refer to corrective maintenance.
WHY: cracked or bent shafts may cause severe damage to equipment and/or extensive down time.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

SHAFT BEARINGS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift
   COND: shafts turning smoothly (no jerking, rough movements); no noise being generated by bearings.
   ACT: operator looks and listens to shaft while unit is in operation.

2. POSSIBLE MALFUNCTIONS

   (a) Loud (squeaking or whining) sound coming from shaft bearings: heard by operator.
   REF: bucket drive manufacturer's maintenance manual.
   IMM OP ADJ: manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch.

   (b) Shaft bearing "race" turning on shaft (possibly making loud noise): seen and/or heard by operator.
   REF: bucket drive manufacturer's maintenance manual.
   IMM OP ADJ: manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch.

3. PREVENTIVE MAINTENANCE
   REF: bucket drive equipment manufacturer's maintenance manual.
   REF: semi-annually.
   COND:
   (a) Loud or unusual noise (indicated by previous experience) coming from shaft bearings: heard by operator.
   ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to component.

   (b) Wipe excessive grease and dirt from around bearing with solvent and rags.

   (c) Use grease gun to apply proper type and amount of lubricant as specified by maintenance manual.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND).

   (e) Listen for unusual sounds (indicated by previous experience) while motor running.

Continued

(f) If noise persists, manually turn motor control switch to OFF, padlock electrical power supply switch to OFF position, and place red LOCK-OUT-TAG on power box; notify supervisor. If no noise, continue with normal operation of plant.

(g) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component. WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

CHAINS

1. NORMAL PROCEDURE
   FREQ: at least once every hour (when operating).
   COND: no more than two estimated inches sag, chain has no breaks.
   ACT: operator looks at chain while unit is in operation.

2. POSSIBLE MALFUNCTIONS

   (a) Too much slack (more than two estimated inches): seen by operator.
   REF: grit collector manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance for adjustment.
   WHY: if there is too much slack, damage may occur to chain or sprocket causing expensive repairs and/or extensive down time.

   (b) Broken or cracked chain: seen by operator.
   REF: grit collector manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: grit collector manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Any evidence of wear or breakage or cracking of link pin: seen by operator.
   ACT:
   (1) Use clamp to hold link together.
   (2) Use hammer and drift pin to remove old link pin.
   (3) Insert new link pin and fasten with nut or cotter key.
   (4) Remove clamp.

   (b) Chain showing signs of wear (link diameter estimated ¼ of original diameter): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: to allow scheduled maintenance and avoid unexpected breakdown.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Scrape off with hand scrapper and hose off with high pressure hose all accumulations of foreign matter.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

Continued

Chains--Continued

(d) Lubricate chain as indicated in manufacturer's maintenance manual.

(e) Clean up oil spills with rags and/or absorbent.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up oil spills with rags and/or absorbent.
WHY: oil on walkways provide slippery surface on which operator can lose his footing and fall causing injury.

BELTS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: belts turning freely, quietly with no squeaking noises; no rip or deep cut across width of belt.
   ACT: operator looks at and listens to belts while they are moving.

2. POSSIBLE MALFUNCTIONS

   (a) Squeaking noise: heard by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF position.

   (b) Distinct smell (like, burning rubber): smelled by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF position.

   (c) Smoke coming from belts: seen and/or smelled by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF position.

   (d) Tear in belt (1/4 of belt width and/or 1/3 of belt thickness): seen by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF position.

3. PREVENTIVE MAINTENANCE
   REF: drive manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Worn belt (frayed or cracked): seen by operator.
   ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Manually remove inspection plate by removing one screw with screwdriver.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

Continued

Belts--Continued

(d) Manually replace inspection plate.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it ON, manually turn motor control switch to ON(HAND).

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Replace inspection plate before starting motor.
WHY: to avoid possibility of operator becoming mangled by belts and pulley.

GUIDE RAILS

1. NORMAL PROCEDURE--None

2. POSSIBLE MALFUNCTIONS

   (a) Rail worn (worn below surface of floor): seen by operator.
   REF: bucket drive manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance for replacement.

3. PREVENTIVE MAINTENANCE
   REF: bucket drive manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND:
   (a) Rail worn (worn below surface of flow): seen by operator.
   ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Follow Steps 1 through 6 in SHUT-DOWN PROCEDURE to drain and clean off components.

   (b) Use clean and structurally sound ladder(s) to enter(exit) grit chamber.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Follow START-UP PROCEDURE (omitting Step 4) to put grit chamber back into operation.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

   (b) Use clean and structurally sound ladder(s) when entering(exiting) grit chambers.
   WHY: slippery or unstable ladders provide possibility that operator could fall into chamber causing possible injury or death.

RECEIVING HOPPER

1. NORMAL PROCEDURE
   FREQ: at least once every 30 minutes when operating unit.
   COND: grit going into hopper and not spilling over sides; grit and organic matter not adhering to sides and bottom of hopper.
   ACT: operator inspects by visual observation the receiving hopper; operator hoses down with high pressure hose sides and bottom of hopper when grit and organic matter are adhering. When grit level in receiving hopper has accumulated to dumping amount as indicated in plant developed operational manual, stop bucket drive by turning control switch to OFF. Dump grit into dump truck by moving control switch to DUMP. Turn control switch to NORMAL to place hopper back to receiving position. Turn bucket drive control switch to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Hopper hanging up (will not release material): seen by operator.
   REF: hopper manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: plant developed operational manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Stop bucket drive by manually turning bucket drive motor control switch to OFF position.

   (b) Empty receiving hopper into dump truck by moving control lever to DUMP.

   (c) Hose down hopper using high pressure hose; empty water from hopper onto the ground.

   (d) Wire brush all rusted spots and chipped paint.

   (e) Apply primer and paint as indicated in plant developed operational manual.

   (f) Manually move control lever to RECEIVE(UP); start bucket drive by manually turning bucket drive motor control switch to ON position.

   (g) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate maintenance time.

4. MAJOR SAFETY FACTORS--None

VALVES

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: valves that should be open are open, valves that should be closed are closed (valve positions to be obtained from supervisor).
   ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

   (a) Handle frozen: operator tries to move handle.
       REF: valve manufacturer's instruction manual.
       IMM OP ADJ: refer to corrective maintenance.

   (b) Broken stem: seen by operator.
       REF: valve manufacturer's instruction manual.
       IMM OP ADJ: refer to corrective maintenance.

   (c) Leaking around stem: seen by operator.
       REF: valve manufacturer's instruction manual.
       IMM OP ADJ: refer to corrective maintenance.

   (d) Valve turns hard: felt by operator as he attempts to turn it.
       REF: valve manufacturer's instruction manual.
       IMM OP ADJ: refer to corrective maintenance.

   (e) Valve turns easily but will not close completely: seen and felt by operator.
       REF: valve manufacturer's instruction manual.
       IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:
   (a) Wipe old grease from valve stem with rag.

   (b) Regrease with proper amount and type of lubricant as indicated in valve manufacturer's instruction manual.

   (c) Move valve through one complete cycle (completely open then completely closed), if it does not completely open(close) refer to corrective maintenance.

   (d) Enter all preventive maintenance on equipment record card.
       WHY: to show work performed for cost accounting and to indicate lubrication time.

4. MAJOR SAFETY FACTORS--None

BAFFLES

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: no scum behind baffle.
ACT: operator looks at baffles and removes any accumulated scum with long handle brush.
WHY: accumulations of scum behind baffles obstruct flow, are unsightly, and cause odors.

2. POSSIBLE MALFUNCTIONS

(a) Baffle fastenings fail (pulled loose, rusted), causing baffle to fall to tank floor: observed by operator.
REF: grit removal manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to drive motor by turning control to OFF. Divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operation manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: grit removal manufacturer's maintenance manual.
FREQ: annually.
COND:
(a) Fastening bolts loose: seen by operator.
ACT: tighten bolts with wrench.

(b) Portions of skirt cracked or missing: seen by operator.
ACT: manually replace cracked or broken skirt panels.

(c) Grease deposits on skirt: seen by operator.
ACT: hose down area behind skirt under peripheral influent channel with high pressure hose.
GEN ACT:
(a) Drain tank by following shut down procedure.

(b) Enter tank using safety measures such as safety ladders, tie-downs, and slip proof boots.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Baffles--Continued

4. MAJOR SAFETY FACTORS

(a) Use proper ladders and safety equipment.
WHY: to prevent falls and possibly injury.

(b) Use proper size wrenches when tightening bolts.
WHY: improper wrenches could slip on bolts and cause injury.

(c) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

WEIRS

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: effluent running evenly over clean weirs.
ACT: operator looks at effluent flowing over weirs, washes down with high pressure hose if any solids build-up is present.

2. POSSIBLE MALFUNCTIONS

(a) Weir not level (effluent not flowing evenly): seen by operator.
REF: grit removal manufacturer's maintenance manual.
IMM OP ADJ: refer to corrective maintenance.
WHY: if the weir is not level, short circuiting will occur causing localized high velocities and bypassing of the majority of the sedimentary basin resulting in solvents carry over.

3. PREVENTIVE MAINTENANCE
REF: grit removal manufacturer's maintenance manual.
FREQ: annually.
COND:
(a) Any evidence of failure of protective coating: seen by operator.
ACT: properly prepare weirs by scraping with brush and reapply protective coating to affected areas.
GEN ACT:
(a) Proceed with shut-down procedure in order to drain tank.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Follow start-up procedure for process.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

PRESSURE INDICATING DEVICE (Gage, Manometer)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: pressure indicating device showing correct pressure (visually observed by operator), pressure reading seems normal for situation as compared from previous experience.
   ACT: operator looks at device, takes reading, compares with previous readings to determine if any wide variations. If wide variations, operator notifies supervisor.

2. POSSIBLE MALFUNCTIONS

   (a) Pressure indicating device showing no pressure: seen by operator.
   REF: pressure indicating device manufacturer's maintenance manual.
   IMM OP ADJ: manually turn blower motor control switch to OFF and notify supervisor.

   (b) Gage showing wide variations in readings: seen by operator.
   REF: pressure indicating device manufacturer's maintenance manual.
   IMM OP ADJ: manually turn blower motor control switch to OFF and notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

ELECTRICAL SWITCHES

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift
COND: all electrical switches operating properly [components start (stop) when the switches are turned to ON(OFF)]; no sticking of switches as operator moves them to various positions.
ACT: operator observes starting and stopping of components as he manually turns switches to ON(OFF) positions. Verifies by touch that switches are not sticking.

2. POSSIBLE MALFUNCTIONS

(a) Switch OFF, component running: seen by operator.
REF: equipment manufacturer's maintenance manual.
IMM OP ADJ: manually turn off power to components by turning main power switch to OFF; immediately notify supervisor.

(b) Switch ON, component not running: seen by operator.
REF: equipment manufacturer's maintenance manual.
IMM OP ADJ: manually turn off power to components by turning main power switch to OFF; immediately notify supervisor.

(c) Switch will not move when changing from ON(OFF) position to OFF(ON) position: seen and felt by operator.
REF: equipment manufacturer's maintenance manual.
IMM OP ADJ: manually turn off power to components by turning main power switch to OFF; immediately notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

SLUICE GATES

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: gates that should be open are open and gates that should be closed are closed (determine by daily procedure and/or daily log book). Flow is unobstructed (no objects in gates closing).
   ACT: operator verifies by observation that gates are in position as indicated above. Operator verifies that there are no objects blocking flow (removes any objects blocking flow).

2. POSSIBLE MALFUNCTIONS

   (a) Sluice gate frozen (operator tries to raise or lower gate): felt by operator.
   REF: sluice gate manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor immediately.

   (b) Sluice gate binds or jumps during opening or closing: seen and felt by operator.
   REF: sluice gate manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: sluice gate manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Edges of gate damaged (torn or burred): seen by operator.
   ACT: lightly file edges smooth with file to remove burrs. Repair tear in gate as designated by maintenance manual.

   (b) Gate slots filled with sediment: seen by operator.
   ACT: jet material from slots with water from high pressure hose.

   (c) Gate slots damaged (bent or burred): seen by operator.
   ACT: use file to file burrs from gate guide. Repair bent places as indicated by maintenance manual.
   GEN ACT:
   (a) Isolate sluice gate by following SHUT-DOWN PROCEDURE for gates above and below gate being inspected in the channel (in order to drain channel on both sides of gate for inspection).

   (b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (c) Lubricate gears with proper lubricant as indicated in reference manual.

   (d) Follow START-UP PROCEDURE for process.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

FREQ: weekly.
GEN ACT:
(a) Manually move sluice gate through one cycle of closing and opening.
WHY: to insure that sluice gate does not freeze up.

4. MAJOR SAFETY FACTORS

(a) Prevent water from squirting back on the operator when water is getting out of the gate slots.
WHY: to prevent infection that the pathogenic organisms in the water could cause if allowed into human orifices.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

TANK (Grit Chamber)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: scum or froth build-up on tank wells above water line.
   ACT: operator uses scraper and manually removes build-up from walls, then hoses with high pressure hose.

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
   REF: plant developed maintenance manual.
   FREQ: semi-annually.
   COND:
   (a) Build-up of scum (grease) or froth on tank walls: seen by operator.
   ACT: clean walls of tank by using hand scraper followed by flushing with high pressure water hose or steam generator.
   WHY: build-up of grease on walls will cause odor problems and is unsightly.
   GEN ACT:
   (a) Close sluice gate using overhead crane.

   (b) Open by-pass sluice gate to divert flow through by-pass channel.

   (c) Manually open drainage valve by turning it to OPEN and drain tank. When tank is approximately 3/4 empty, turn off blower motor by turning switch to OFF.

   (d) Put on protective rubber gloves, boots, and apron.

   (e) Enter(exit) tank using clean and sound ladder.

   (f) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

   (g) Manually close draining valve by turning it to CLOSE.

   (h) OPEN sluice gate using overhead crane.

   (i) Close by-pass sluice gate.

   (j) When tank is approximately 1/4 full, turn blower motor on by manually turning switch to ON.

   (k) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate maintenance time.

Continued

4. MAJOR SAFETY FACTORS

(a) Put on protective rubber gloves, boots, and apron.
WHY: to prevent infection to operator due to bacteria entering cuts on body.

(b) Enter tank using clean and sound ladder.
WHY: slippery or unstable ladder provides opportunity for operator to fall into basin with possibility of concussion or broken limbs.

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshall.
   ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
   WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

   (a) Equipment missing: seen by operator.
   REF: fire fighting equipment maintenance manual.
   IMM OP ADJ: notify supervisor.

   (b) Equipment damaged: seen by operator.
   REF: fire fighting equipment maintenance manual.
   IMM OP ADJ: notify supervisor

3. PREVENTIVE MAINTENANCE
   REF: fire fighting maintenance manual.
   FREQ: annually.
   COND:
   (a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
   ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
   GEN ACT:
   (a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
   WHY: low weight indicates extinguisher should be recharged.

   (b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is not low.

   (c) If pressure is low, extinguisher should be recharged by referring to the equipment maintennace manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRST AID KIT

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed on inventory sheet in kit.
   ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies; notes position of kit.
   WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

   (a) Kit is missing: seen by operator.
   REF: first aid kit manual.
   IMM OP ADJ: notify supervisor.

   (b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
   REF: first aid kit manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: first aid kit manual.
   FREQ: at least once every week.
   COND:
   (a) Some supplies missing: seen by operator.
   ACT: determine actual amount of supplies missing.
   GEN ACT:
   (a) Open kit and inspect supplies for deficit using inventory sheet.

   (b) Replenish first aid supplies by using inventory sheet in lid and list of supplies operator has decided is missing.

   (c) Close kit and fasten catch.

   (d) Enter all preventive maintennace on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

PRIMARY SEDIMENTATION

(Second Draft)

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
Technology Training Programs

U. S. Environmental Protection Agency
Office of Water Program Operations
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The first draft of this workbook was prepared by Ronald A. Bryant, Assistant Superintendent, South River Water Pollution Control Plant, Atlanta, Georgia; D. L. Driggers, Instructor, Environmental-Chemical Technology Department, Greenville Technical Education Center, Greenville, South Carolina; and William J. Hull, Foreman, Intrenchment Creek Water Pollution Control Plant, Atlanta, Georgia.

Additional revision and evaluation were provided by Albert F. Eiss, Learning Systems Consultant, West Georgia Educational Services Center, Carrollton, Georgia; Dana W. Love, Jr., Associate Director of Continuing Education, Environmental Systems Engineering, Clemson University, Clemson, South Carolina; Wade H. Ponder, Training Coordinator, Environmental Systems Engineering, Clemson University; and Robert L. Reynolds, Education and Training Consultant, Atlanta, Georgia.

Editorial work on the second draft of this manual was carried out by John S. Cox, Senior Research Assistant, Environmental Systems Engineering, Clemson University.

PRIMARY SEDIMENTATION

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START-UP PROCEDURE FOR PROCESS

1. Verify by observation that the motor (collector drive and pump) control switches are in the OFF position; electrical power supply switch in OFF position and padlocked; red LOCK-OUT-TAG on power box for switch. WHY: to start up any process, all motors and equipment should be off in order to perform the start-up sequence properly.

2. Verify that the sludge collector system (motor, clutch, gear box, sprocket, chain, flights) is functional as follows:

   (a) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it on.

   (b) Manually disengage clutch by moving clutch lever to DISENGAGE position.

   (c) Manually start motor by manually turning control switch ON.

   (d) Engage clutch by manually moving clutch lever to ENGAGE position.

   (e) Observe components of system to verify that motor, gear box shaft, sprocket shaft, flights and chain are moving at correct speed with no jerky motion determined by previous experience and that no unusual sounds are produced by the motor and gear box. *If any component is not functioning properly, refer to corrective maintenance for repair before proceeding.*

   (f) Disengage clutch by manually moving clutch lever to DISENGAGE position.

   (g) Stop motor by manually turning control switch OFF.
   WHY: if a sedimentation basin is filled before repairs are made, it will probably have to be drained again to make the repairs.

3. Verify that drain is closed by observing that drain plug is in place or that valve is closed. (This step only for basins with gravity drains.) If drain is not closed, proceed to manually close valve or place drain plug.

4. Manually close telescopic valve by moving operating wheel (handle) to CLOSED position. Verify by observation that the brass tube is closed. If it is not closed, refer to corrective maintenance.

5. Move skimmer trough handle through at least two open and closed cycles to insure that it turns smoothly. Leave in CLOSED position. *If skimmer trough does not operate properly, refer to corrective maintenance for repair before proceeding.*
   WHY: if the trough will rotate through two cycles, it will probably continue to function.

6. Manually open sluice gate by moving operating wheel (handle) to OPEN position. Verify by observation that influent is entering basin. *If gate does not open, refer to corrective maintenance for repair.*

Continued

7. Verify that sludge pumps are working as follows:
   (a) Start motor by manually turning control switch ON.
   (b) Verify by observation that each pump shaft is moving.
   (c) Stop motor by manually turning control switch OFF.

   If any pump is not functional, refer to corrective maintenance.

8. When the level in the basin is one foot below the weirs, start the sludge collector system as follows:
   (a) Start motor by manually turning control switch ON.
   (b) Engage clutch by manually moving clutch lever to ENGAGE position.
   (c) Observe components of system to verify that motor, gear box shaft, sprocket, shaft, flights and chain are moving with no jerky motion and at speed normal as determined by previous experience and that no unusual sounds are produced by the motor and gear box.

   If any component is not functioning properly, refer to corrective maintenance for repair.

9. When the level in the basin reaches the weirs, observe whether effluent spills over all weirs at the same time. *If effluent does not spill over all weirs at the same time, mark (i.e. with chalk) the weirs where the spill first starts and refer to corrective maintenance for adjustment.*

10. When sufficient sludge has accumulated (level is within normal operating range on depth gage) open telescopic valve (1/2 way or the normal operating position as indicated by previous experience) by manually moving the operating wheel (handle) in the OPEN direction.

11. Obtain from supervisor the sludge transfer valve arrangement to be used and open those valves necessary by moving the operating wheel(s) (handle) to the OPEN position.

12. When the level in the sludge well is within the normal operating range, indicated on the gage stick, start the sludge pump by manually turning the control switch ON.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Manually close sluice gate by moving operating wheel (handle) to CLOSED position. Verify by observation that influent has stopped entering basin. *If influent has not stopped entering basin, refer to corrective maintenance.*

2. Manually open telescopic valve (1/2 way or to normal operating position as indicated by previous experience) by moving operating wheel (handle) to draw all sludge from basin to sludge well.

3. Pump sludge from sludge well as follows:
   (a) Determine from supervisor the sludge transfer valve arrangement to be used and manually open these valves by turning the operating wheel(s) (handle) to the OPEN position.
   (b) Start motor by turning control switch ON.

4. When all sludge has been drawn from the basin (only effluent is being brought into the sludge well) and pumped from the sludge well, change the sludge transfer valves arrangement to send the effluent to the next process. Continue to use sludge pumps to aid in emptying the basin.

5. Stop sludge collector as follows:
   (a) Manually disengage clutch by moving clutch lever to DISENGAGE position.
   (b) Manually stop motor by turning control switch OFF.

6. Open drain by removing drain plug with hands or manually turning drain valve operating wheel (handle) to OPEN position (only for basins with gravity drains).

7. Obtain additional (portable) pumps and use to empty basin.

8. As level in the basin falls below the weirs, use high pressure hose to wash down weirs and baffles and flush out scum line.
   WHY: if components are not hosed down as they are exposed, solids that adhere will dry and begin to cause odor problems. Solids that have dried on components are more difficult to remove.

9. As level in the basin continues to fall, use high pressure hose to wash down all components (walls, flights, chain, etc.) as they are exposed. Intermittent turning on and off of the sludge collector system may aid in this cleaning.
   WHY: if components are not hosed down as they are exposed, solids that adhere will dry and begin to cause odor problems. Solids that have dried on components are more difficult to remove.

10. When the level in the basin reaches the floor, discontinue use of the additional pumps.

Continued

11. When the basin has been completely cleaned and emptied, manually shut down sludge pumps by turning control switch OFF. Padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

Component/Step	Frequency
1. Sluice Gates	every 4 hours
2. Motor (Flight Drive)	every 8 hours
3. Clutch	every hour
4. Gear Box	every 8 hours
5. Sprocket	" " "
6. Chain	every hour
7. Flights	" "
8. Skimmer Trough	every 4 hours
9. Baffles	" " "
10. Weirs	every 8 hours
11. Telescopic Valve	" " "
12. Sludge Well	every hour
13. Grease Pit	every 4 hours
14. Motor (Pump)	every 8 hours
15. Variable Speed Drive	every hour
16. Pumps (Piston type-belt driven)	every 4 hours
17. Valves	" " "
18. Piping	every 8 hours
19. Time Clock	" " "
20. Density Meter	every hour
21. Limit Switch	every 8 hours
22. First Aid Kit	" " "
23. Fire Fighting Equipment	" " "
24. Effluent Sampling	every 2 hours
25. Influent Sampling	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

Component/Step	Frequency
1. Motor (Flight Drive)	monthly
2. Clutch	weekly
3. Gear Box	semi-annually
4. Sprocket	weekly
5. Chain	"
6. Flights	annually
7. Rail (Flight Guide)	"
8. Sluice Gates	weekly/annually
9. Skimmer Trough	weekly
10. Grease Pit	annually
11. Telescopic Valve	weekly
12. Sludge Well	annually
13. Motor (Pump)	monthly
14. Variable Speed Drive	weekly
15. Pumps (Piston type-belt driven)	weekly/semi-annually
16. Valves	monthly
17. Piping	annually

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Color

   (a) Black: seen by operator.
   CAUSE:
   (1) Waste has turned septic because of:
      a. low flow in collection system.
      b. high temperature.
      c. extended stay in collection system.
      d. toxic materials introduced into collection system.

   (b) Any color not normal for a particular plant (determined by entries of abnormalities in plant operations log): seen by operator.
   CAUSE: unusual industrial waste being introduced into collection system.

2. Odor

   (a) Scent like rotten eggs: smelled by operator.
   CAUSE:
   (1) Waste has turned septic, thereby generating H_2S because of:
      a. low flow in collection system.
      b. its high temperature.
      c. extended stay in collection system.
      d. shock load of toxic materials introduced into collection system.

   (b) Scent like petroleum products: smelled by operator.
   CAUSE: dumping of petroleum products (gas, oil, kerosene, etc.) by industry and business (service stations, etc.).

   (c) Scent like bleach: smelled by operator.
   CAUSE: excessive prechlorination.

3. Rate of Flow

   (a) High (level of effluent is at top of the weir): seen by operator.
   CAUSE:
   (1) Too much infiltration into collection system.
   (2) Shock load caused by industries dumping unusual volume of waste.

   (b) Low (no flow over weirs): seen by operator.
   CAUSE:
   (1) Stopped up collection lines.
   (2) Too much exfiltration from collection system.

Continued

4. Level in Sludge Well

   (a) Sludge level too high (higher than normal operating range on depth gage): operator reads depth gage.
   CAUSE:
      (1) Rate at which sludge is being removed from the well has been decreased.
      (2) Rate at which sludge is being introduced into well has been increased.

   (b) Sludge level too low (lower than normal operating range on depth gage): operator reads depth gage.
   CAUSE:
      (1) Sludge intake line to well is stopped up.
      (2) No sludge available from clarifier.
      (3) Rate at which sludge is being removed from the well has been increased.
      (4) Rate at which sludge is being introduced into the well has been decreased.

   (c) Noticeable change in rate at which sludge level is rising: operator reads depth gage over a period of time.
   CAUSE:
      (1) Rate at which sludge is being removed from the well has been decreased.
      (2) Rate at which sludge is being introduced into well has been increased.

   (d) Noticeable change in rate at which sludge level is dropping: operator reads depth gage over a period of time.
   CAUSE:
      (1) Sludge intake line to well is stopped up.
      (2) No sludge available from clarifier.
      (3) Rate at which sludge is being removed from the well has been increased.
      (4) Rate at which sludge is being introduced into the well has been decreased.

MAJOR SAFETY FACTORS--None

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Composite--influent

FREQ: one sample every 8 hours composed of parts at each interval in the 8 hour period as indicated by the lab.
ACT: use clean sampling apparatus and dip sample from wastestream at the point the wastestream enters the clarifier, pour into clean container, cap, and immediately place in lab refrigerator. The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, influent composite sample for 8:00 a.m.--4:00 p.m. shift would be as follows:

Time Taken	Flow Rate, MGD	Volume of Sample, *mℓ*
10:00 a.m.	7.0	700
12:00 N	6.5	650
2:00 p.m.	6.0	600
4:00 p.m.	5.5	550
	Total Shift Sample	2500 *mℓ*

In the above example, 100 *mℓ* of sample were taken for each 1 MGD flow rate. Determination of this sample volume to flow rate ratio is as follows:

(a) Obtain from laboratory the total volume of sample needed to conduct tests for 24-hour period (assume 6 ℓ/day)

(b) Determine the number of samples to be taken in a 24-hour period (assume one every two hours)

$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed (from part (a) above) by the number of samples to be taken (from part (b) above) to obtain the *average* volume needed for each sample:

$$\frac{6\ \ell}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5\ \ell}{\text{sample}}$$

(d) Divide the average volume per sample (from part (c) above) by the average daily flow of wastewater through the plant (assume 5 MGD)

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5 \text{ MGD}} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}}$$

Continued

(e) Multiply the sample volume per 1 MGD (from part (d) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD):

$$10{:}00 \text{ a.m. sample} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}} \times 7.0\ \text{MGD} = 0.70\ \ell = 700\ m\ell$$

WHY: A composite sample will give a more accurate representation than a grab sample, because the wastestream characteristics are continually changing as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed.

2. Composite--effluent

FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
ACT: use clean sampling apparatus and dip sample from wastestream at the point the wastestream leaves the clarifier, pour into clean container, cap, and immediately place in lab refrigerator. The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, effluent composite sample for 8:00 a.m.--4:00 p.m. shift would be as follows:

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$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed (from part (a) above) by the number of samples to be taken (from part (b) above to obtain the *average* volume needed for each sample:

$$\frac{6\ \ell}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5\ \ell}{\text{sample}}$$

Continued

Normal Sampling--Continued

(d) Divide the average volume per sample (from part (c) above) by the average daily flow of wastewater through the plant (assume 5 MGD)

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5\ \text{MGD}} = \frac{0.1\ \ell/\text{sample}}{1\ \text{MGD}}$$

(e) Multiply the same volume per 1 MGD (from part (d) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD):

10:00 a.m. sample = 0.1 ℓ/sample x 7.0 MGD = 0.70 ℓ = 700 $m\ell$

WHY: A composite sample will give a more accurate representation than a grab sample because the wastestream characteristics are continually changind as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTOR (Flight Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: motor temperature within range on name plate, running with normal sound as determined by previous running of motor, shaft turning, and bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to ON (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearings for vibration and heat.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (d) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (e) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually disengage clutch by moving clutch lever to NEUTRAL. Manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: tighten motor mounts bolts with wrench.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint or black stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: If motor is drawing excessive amperage (greater than that stamped on the name plate) a fire could occur.

(c) Electrical connections loose or frayed: seen by operator.
ACT: refer to corrective maintenance.
WHY: loose or frayed wires may cause a fire hazard.

GEN ACT:

(a) Manually disengage clutch by moving clutch lever to disengage position.

(b) Manually turn collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(c) Use ladder and harness when preventive maintenance is at a high (deep) position, or other dangerous position.

(d) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(e) Tighten end plate bolts with a wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

(f) Use grease gun to apply proper amount and type of lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

Continued

(g) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn collector drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(i) Manually engage clutch by moving clutch lever to ENGAGE.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually disengage clutch by moving clutch lever to DISENGAGE position and manually turn collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in area that is difficult to reach.
WHY: to prevent falls and resulting injury.

CLUTCH

1. NORMAL PROCEDURE
FREQ: at least once every hour.
COND: input and output shafts turning smoothly, no unusual sound as determined by previous experience.
ACT: operator looks at input and output shafts and listens for sounds as determined by previous experience.

2. POSSIBLE MALFUNCTIONS

(a) Input shaft turning, output shaft not turning, lever in engaged position: seen by operator.
REF: clutch manufacturer's maintenance manual.
IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGED position, manually cut power to motor by turning control switch OFF, immediately notify supervisor, and refer to corrective maintenance.
WHY: disengage to stop further damage from occurring.

(b) Clutch will not engage/disengage when clutch lever is moved to the ENGAGE/DISENGAGE position: operator attempts to engage/disengage clutch.
REF: clutch manufacturer's maintenance manual
IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGED position, manually cut power to motor by turning control switch OFF, immediately notify supervisor, and refer to corrective maintenance.

(c) Clutch making unusual noise: heard by operator.
REF: clutch manufacturer's maintenance manual.
IMM OP ADJ: manaully disengage clutch by moving clutch lever to DISENGAGE position, manually cut power to motor by turning control switch OFF, immediately notify supervisor, and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: clutch manufacturer's maintenance manual.
FREQ: weekly.
COND: none.
GEN ACT:
(a) Manually disengage clutch by moving clutch lever to DISENGAGE position.

(b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(c) Use wrench to unbolt clutch housing.

(d) Visually inspect clutch plates, if clutch plates are worn, refer to corrective maintenance for repair. If not worn, proceed with remounting of clutch housing. (worn--plates slipping, uneven motion)

(e) Use wrench to remount clutch housing.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Manually engage clutch by moving clutch lever to ENGAGE.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually disengage clutch by moving clutch lever to DISENGAGE position and manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause loss of fingers.

GEAR BOX

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hour shift
   COND: oil gage shows oil level between high and low marks, gears making no grinding or clanking noise.
   ACT: operator listens to gear box and looks at oil gage, adds oil as shown in manufacturer's manual, if necessary. If oil is low, visually checks for leaks in gear box. If oil is seeping out (film), operator records leak and observes it for a period of time to determine the severity of leak.
   WHY: improper oil or not enough may damage gear box components.

2. POSSIBLE MALFUNCTIONS

   (a) Gears making unusual noise: heard by operator.
   REF: gear box manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGE position, manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Oil leak (puddle): seen by operator.
   REF: gear box manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGE position, manually cut power to motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: gear box manufacturer's maintenance manual
   FREQ: semi-annually
   COND:
   (a) Metal shavings found as old oil is drained from gear box: operator feels oil and looks for metal shavings.
   ACT: refer to corrective maintenance for further inspection.
   WHY: metal shavings in oil indicate worn gears.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Manually disengage clutch by moving clutch lever to NEUTRAL.

   (c) Drain oil by removing oil drain plug with wrench.

Continued

(d) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(e) Replace plug with wrench.

(f) Replace correct amount of proper oil as designated by manufacturer's maintenance manual.
WHY: too much, too little, or the wrong type of oil can cause damage to gear box components.

(g) Clean area of any oil spills with rags and/or oil absorbent.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(i) Engage clutch manually by moving clutch lever to ENGAGE.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, place red LOCK-OUT-TAG on power box for switch and disengage clutch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up oil spills with rags and/or absorbent.
WHY: oil on walkways provide slippery surface on which an operator can lose his footing and fall.

SPROCKET

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: sprocket turning smoothly, no teeth missing; meshing with chain links.
   ACT: operator looks at sprocket turning and at each of its teeth.

2. POSSIBLE MALFUNCTIONS

   (a) Sprocket not turning: seen by operator.
   REF: flight manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGE position; cut power to flight drive motor by turning control switch OFF.

   (b) Sprocket turning, chain not moving: seen by operator.
   REF: flight manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGE position; cut power to flight drive motor by turning control switch OFF.

   (c) Teeth are missing: seen by operator.
   REF: flight manufacturer's maintenance manual.
   IMM OP ADJ: manually disengage clutch by moving clutch lever to DISENGAGE position; cut power to flight drive motor by turning control switch OFF.

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Crack in tooth: seen by operator.
   ACT: refer to corrective maintenance.

   (b) Excessive wear of teeth (outer edge of teeth lie below top of chain when chain is fully engaged): seen by operator.
   ACT: refer to corrective maintenance.
   WHY: worn teeth may cause chain to slip which will create major operational problems.

   GEN ACT:
   (a) Manually disengage clutch by moving clutch lever to DISENGAGE position.

   (b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

Continued

(d) Tighten set screw in sprocket with allen wrench.
WHY: when a sprocket becomes loose, it can easily cause serious damage to shaft.

(e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(f) Manually engage clutch by moving clutch lever to ENGAGE position.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually disengage clutch and manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

CHAIN

1. NORMAL PROCEDURE
FREQ: at least once every hour
COND: no more than 2 estimated inches sag, chain has no breaks.
ACT: operator looks at chain while unit is in operation.

2. POSSIBLE MALFUNCTIONS

(a) Too slack (more than 2 estimated inches sag): seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: refer to corrective maintenance for adjustment.
WHY: if chain is too slack, damage may occur to chain or sprocket causing expensive repairs and/or extensive down time.

(b) Broken or cracked chain: seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: sludge collector manufacturer's maintenance manual.
FREQ: weekly.
COND:

(a) Chain showing signs of wear (links diameter estimated 1/4 of original diameter): seen by operator.
ACT: refer to corrective maintenance.
WHY: to allow scheduled maintenance and avoid unexpected break down.

(b) Links or link pins broken or cracked: seen by operator.
ACT: refer to corrective maintenance.

GEN ACT:

(a) Manually turn collector motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually disengage clutch by moving clutch lever to NEUTRAL.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Hose chain down using high pressure hose.

(e) Lubricate chain using proper lubricant as indicated in manufacturer's maintenance manual. Clean up oil spills with rags and/or absorbent.
WHY: oil on walkways provide slippery surface on which an operator can lose his footing and fall.

Continued

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn drive motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Engage clutch manually by moving clutch lever to ENGAGE.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn collector motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch and disengage clutch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up oil spills with rags and/or absorbent.
WHY: oil on walkways provide slippery surface on which an operator can lose his footing and fall.

FLIGHTS

1. NORMAL PROCEDURE

FREQ: at least once every hour.
COND: flights moving at a constant rate; no loose shoes; no broken flights; no scum or sludge build up on flights.
ACT: operator looks at flights, including shoes, making sure that during his 8-hour shift, he sees all the flights. Hoses down flights with high pressure hose to remove scum or sludge build up.
WHY:

(a) Broken flights or loose shoes will cause damage to equipment resulting in expensive repairs and/or extensive down time.

(b) Less than half the flights are visible at any one time.

(c) Accumulation of debris on flights will result in decreased efficiency, unpleasant odors and unsightly appearance.

2. POSSIBLE MALFUNCTIONS

(a) Flights not moving: seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: if clutch is not disengaged, accidental start-up may cause damage to equipment.

(b) Broken flights: seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: if clutch is not disengaged, accidental start-up may cause damage to equipment.

(c) Loose shoe: seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: if clutch is not disengaged, accidental start-up may cause damage to equipment.

Continued

(d) Worn shoe (shoe is worn to the level of the flight): seen by operator.
REF: sludge collector manufacturer's maintenance manual.
IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: if clutch is not disengaged, accidental start-up may cause damage to equipment.

3. PREVENTIVE MAINTENANCE
REF: plant developed maintenance manual.
FREQ: annually.
COND:
(a) Cracked or deteriorated flights: operator looks for cracks in flights and punches flights with screwdriver to determine if they are rotting.
ACT:
(1) Use wrench to remove bolts that mount flights to chain.
(2) Manually remove old flight.
(3) Use wrench to insert bolts and manually mount new flight to chain.
WHY: defective flights will cause damage to equipment and/or extensive down time.
(b) Worn or broken shoes: seen by operator.
ACT:
(1) Use wrench to remove bolts that mount shoe to flight.
(2) Manually remove old shoe.
(3) Use wrench to insert bolts and manually mount new shoe to flight.
GEN ACT:
(a) Drain sedimentation basin by following shut-down procedure.
(b) Use clean and structurally sound ladder(s) to enter (exit) sedimentation basin.
(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.
(d) Put basin back into operation by following start-up procedure.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch and disengage clutch before performing any work on the equipment.
WHY: accidental start-up may entangle operator or his clothing in chain, sprocket, flights or gears causing loss of fingers, hand or feet.

(b) Use clean and structurally sound ladders when entering (exiting) basin.
WHY: slippery or unstable ladder(s) provide opportunity for operator to fall into basin with possibility of concussion or broken arm or leg.

LIMIT SWITCH

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: motor operating properly.
   ACT: operator looks at flights and motor while manually turning switch OFF then ON.

2. POSSIBLE MALFUNCTIONS

   (a) Switch OFF, motor running: seen by operator.
   REF: sludge collector manufacturer's maintenance manual.
   IMM OP ADJ. cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Switch ON, motor not running: seen by operator.
   REF: sludge collector manufacturer's maintenance manual.
   IMM OP ADJ: cut power to motor by turning control switch OFF, disengage clutch by moving clutch lever to NEUTRAL; divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

RAIL (Flight Guide)

1. NORMAL PROCEDURE
   FREQ: once every 8-hour shift.
   COND: flights moving 3 feet per minute (or rate indicated by flight guide manual).
   ACT: operator observes movement of flights.

2. POSSIBLE MALFUNCTIONS

   (a) Rail worn (below surface of floor): seen by operator.
       REF: sludge collector manufacturer's maintenance manual.
       IMM OP ADJ: refer to corrective maintenance for replacement.

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Rail worn (below surface of floor): seen by operator.
       ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Divert flow from basin and empty sedimentation basin by following shut-down procedure.

   (b) Use clean and structurally sound ladder(s) to enter (exit) sedimentation basin.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Put sedimentation process back into operation by following start-up procedure.

   (e) Enter all preventive maintenance on equipment record card.
       WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Use clean and structurally sound ladder(s) to enter (exit) sedimentation basin.

   (b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch and disengage before performing any work on the equipment.
       WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

SLUDGE WELL

1. NORMAL PROCEDURE
   FREQ: at least once every hour
   COND: sludge level within normal operating range indicated on depth gage. Sludge rising or falling at normal rate determined by previous experience.
   ACT: operator looking at depth gage, making constant adjustments to keep the depth of sludge within normal limits indicated by markings on gage. If the level of sludge is tending to rise, the operator makes minute adjustments to increase pumping the sludge out of the well by speeding up the pump motor and by closing the valve allowing less sludge to enter the well. If the level of sludge is tending to drop, the operator makes minute adjustments to decrease the amount of sludge pumped out of the well by slowing the speed of the pump motor and by opening the valve allowing more sludge to enter the well. In making operational adjustments, the valve should be used as the primary adjusting device.
   WHY:
   (a) If well runs dry, pump damage could occur; if well overflows, odor and health hazards will occur.

   (b) If level drops below/rises above the normal operating range, the well will be pumped dry/overflow before operational adjustments can correct the situation.

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual; plant developed maintenance manual.
   FREQ: annually.
   COND:
   (a) Sand in well: seen by operator.
   ACT: remove sand with shovels and buckets or mechanical buckets, wash organic particles from sand; dispose of sand by burying.
   WHY: sand build up reduces effective volume of well and will cause excessive wear of pumps.

   (b) Build up of sludge in piping and valves: seen by operator.
   ACT: clean piping and valves by hand and rodding, then flush with water from high pressure hose.
   WHY: build up will reduce carrying capacity of pipe and eventually cause stoppage. Prevent excessive down time to unstop piping.

   (c) Excessive wear to valve parts (valve starts leaking): seen by operator
   ACT: replace worn parts with new parts.
   WHY: worn parts will cause malfunction of valves. Prevent excessive down time to repair valves.

Continued

GEN ACT:

(a) Manually close telescopic valve by turning control wheel (handle) to CLOSED position.

(b) Pump down and drain well with sludge pumps.

(c) Test well for explosive and toxic gases and oxygen content with test kits from laboratory. If gases register too high or oxygen too low, notify supervisor.

(d) Enter well wearing protective clothing, safety harness with man outside of well. Non sparking tools, safety lights.

(e) Dismantle valves with wrench.

(f) Partially dismantle piping (enough to inspect and clean) with wrench.

(g) Inspect valves and piping visually and by hand.

(h) Assemble piping and valves with wrench.

(i) Remove chipped and loose paint from exposed metal with wire brush.

(j) Paint exposed metal with proper paint as indicated by maintenance manual or designated by supervisor.

(k) Exit well with safety harness attached.

(l) Manually open telescopic valve by turning control wheel (handle) to OPEN position.

4. MAJOR SAFETY FACTORS

(a) Check well for explosive and toxic gases.
WHY: explosion or suffocation could result from entering a well that contains gases.

(b) Wear protective clothing.
WHY: to avoid cuts and scratches that could result in serious infections.

(c) Wear safety harness and have man outside of well.
WHY: to remove man inside well in case of emergency.

TELESCOPIC VALVE

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: valve will open and close. Valve is positioned so that the inlet rim is slightly above the liquid surface level of the peripheral inlet channel.
   ACT: operator turns valve wheel and looks at flow to verify that with opening and closing of valve, flow increases and decreases; operator looks at the telescopic valve and notes that: the valve is raised so that the inlet rim is above the surface level of the channel. The operator manually adjusts the position of the telescopic valve if necessary.
   WHY:
   (a) When the telescopic valve has flow going into it, an unmeasured amount of solids will be lost from the secondary process.

   (b) The flow into the telescopic valve is additional flow that has to be repumped by the plant lift pumps.

2. POSSIBLE MALFUNCTIONS

   (a) Wheel turns but brass tube does not go up or down: seen by operator.
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance and notify supervisor immediately.

   (b) Brass tube goes down but sludge will not run: seen by operator.
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance and notify supervisor immeidately.

   (c) Telescopic valve moves up and down as hand wheel turns with much difficulty: seen and felt by operator.
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: none.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's maintenance manual.
   FREQ: weekly
   COND:
   (a) Set screws loose or missing: seen by operator.
   ACT: tighten or replace set screws with allen wrench.
   WHY: loose set screws will cause pins to fall out or shear off.

   (b) Stem is rusty or caked with dried grease: seen by operator.
   ACT: clean with rag and oil valve stem with oil designated in maintenance manual. Manually run valve through complete range up and down. (Use both hands to turn the valve wheel.)
   WHY: a rusty stem or caked stem will become hard to turn and may cause a pin to slip or shear off.

Continued

Telescopic Valve--Continued

GEN ACT:

(a) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Use both hands to turn the valve wheel. Do not spin the valve wheel.
WHY: spinning the valve wheel may cause the spokes to hit and injure the fingers when trying to stop the wheel.

DENSITY METER

1. NORMAL PROCEDURE
FREQ: at least once every hour.
COND: meter shows reading on gage scale which is determined by type of sludge.
ACT: operator looks at meter to determine where the arrow points on the gage. If sludge too thin, operator allows it to collect more. If too thick, allows it to thin out.

2. POSSIBLE MALFUNCTIONS

(a) Meter indicates dense sludge when direct observation shows that sludge is obviously thin: operator looks at meter and sludge being pumped from sludge well.
REF: density meter manufacturer's operation manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Meter indicates thin sludge when direct observation shows that sludge is obviously thick: operator looks at meter and sludge being pumped from sludge well.
REF: density meter manufacturer's operation manual.
IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

MOTOR (Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: motor only warm, running with low even hum, free of vibration, shaft turning, bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is OFF) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch OFF; start alternate pump. Refer to corrective maintenance.

   (b) Motor stopped (shaft not turning): seen and/or heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button (if reset motor fails to continue running, manually cut power to motor by turning control switch OFF; start alternate pump). Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch OFF; start alternate pump. Refer to corrective maintenance.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch OFF; start alternate pump. Refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch OFF. Notify supervisor and refer to corrective maintenance.

   (f) Smoke rising out of casing: seen and/or smelt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch OFF, start alternate pump. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals and motor windings.

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust, thereby producing a fire hazard.

Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

VARIABLE SPEED DRIVE (Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every hour.
   COND: running quietly with no vibrations.
   ACT: operator feels and listens to drive component.

2. POSSIBLE MALFUNCTIONS

   (a) Rattling or thumping noises: heard by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: cut power to pump motor by turning control switch OFF and start alternate pump. Refer to corrective maintenance.

   (b) Motor turning, output shaft of drive not turning: seen by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: cut power to pump motor by turning control switch OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: drive manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Worn belt (cracked or frayed): seen or heard by operator.
   ACT: notify supervisor and refer to corrective maintenance.
   GEN ACT:
   (a) While drive is running, manually turn selector wheel to highest speed position.

   (b) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (c) Remove inspection plate by prying off with screwdriver.

   (d) Inspect belt by observation while prodding belt with an insulated screwdriver.

   (e) Manually replace inspection plate.

   (f) Use grease gun to lubricate with correct amount of proper lubricant as designated by drive manufacturer's maintenance manual.

   (g) Clean up spilled lubricant with rags and/or absorbent.

   (h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

Continued

(i) While component is running, move speed selector through entire speed range.
WHY: changing speed setting while drive is not running will damage drive.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Replace inspection plate before starting motor.
WHY: to avoid possibility of operator becoming mangled by belt and pulleys.

(c) Use insulated-handled screwdriver while inspecting belts.
WHY: to prevent electric shock in case of accidental start-up.

(d) Clean up spilled lubricant with rags and/or absorbent.
WHY: spilled lubricant could cause slippery surface which may cause operator to slip and injure back, head, or other parts of body.

PUMPS (Piston Type--Belt Driven)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours
COND: start pumping at the correct pressure as specified on gage with no vibrations or noises as determined by previous experience and no leaking. Automatic oiler is full of clean oil.
ACT: operator looks at gage for pressure and at pump for leaks, listens for any unusual noises; fills automatic oiler with proper oil as designated by manufacturer's maintenance manual, and manually turns automatic oiler on when starting pump; operator looks and listens for any unusual vibrations.

2. POSSIBLE MALFUNCTIONS

(a) Pump running but no sludge is being discharged and/or discharge pressure gage shows no pressure: sludge seen and gage read by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

(b) Pump leaking (excessive amount of water around gland): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

(c) Pump pulley turning but piston not working: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

(d) Motor running but pump pulley not turning: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

(e) Pump knocking or making unusual noise: heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

(f) Motor not running: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch OFF and start alternate pump. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Frayed, slack or cracked belt: seen by operator as he presses on belt.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Check oil in gear box for proper amount designated by ranges on stick by looking at sight gage or dipstick; add oil if necessary.

(d) Clean up any spilled oil with rags and/or absorbent.

(e) Use screwdriver to tighten screws in pulleys.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment

(b) Remove drain plug with wrench and completely drain old oil.

(c) Replace drain plug with wrench and fill to correct level with proper oil as designated by the manufacturer's maintenance manual.

(d) Remove gear box cover, check for worn teeth (teeth not meshing at least one quarter of an inch), and broken teeth. Determine, by trying to move with hand if gears are loose on shaft (if loose, tighten with allen wrench).

(e) Replace gear box cover.

(f) Fill gear box to the correct level with the proper oil designated in the manufacturer's maintenance manual.

(g) Clean up any spilled oil with rags and/or lubricant.

Continued

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricants with rags and/or absorbent. WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

VALVES

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: valves that should be open are open, valves that should be closed are closed (valve positions to be obtained from supervisor).
ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

(a) Handle frozen: operator tries to move handle.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Broken stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(c) Leaking around stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(d) Valve turns hard: felt by operator as he attempts to turn it.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(e) Valve turns easily but won't close completely: seen and felt by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: valve manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:
(a) Wipe old grease from valve stem with rags.
(b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.
(c) Move valve through one complete cycle (completely open then completely closed), if it does not completely open (close), refer to corrective maintenance. (Use both hands to turn the valve wheel.)

4. MAJOR SAFETY FACTORS

(a) Use both hands to turn the valve wheel. Do not spin the valve wheel.
WHY: spinning the valve wheel may cause the spokes to hit and injure the fingers when trying to stop the wheel.

PIPING

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: no visible leaks.
   ACT: operator looks at all pipe and fittings that are visible.

2. POSSIBLE MALFUNCTIONS

   (a) Minor leak (dripping of water): seen by operator.
   REF: plant developed maintenance manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (b) Major leak (steady stream, gushing of water): seen by operator.
   REF: plant developed operation manual.
   IMM OP ADJ: alter valve arrangement to bypass leak and immediately notify supervisor. Manually close valves to isolate leak and start alternate units.

3. PREVENTIVE MAINTENANCE
   REF: plant developed maintenance manual.
   FREQ: annually.
   COND:
   (a) Minor leaks (dripping) of water: seen by operator.
   ACT: repair by tightening joints that leak. Patch leaks along joint of pipe with material specified in plant developed maintenance manual.

   (b) Cracks in expansion joints: seen by operator.
   ACT: for replacement, refer to corrective maintenance.
   GEN ACT:
   (a) Look for conditions above and take appropriate actions.

   (b) Remove cracked and peeling paint and rust with wire brush.

   (c) Repaint with proper kind and color of paint as designated in plant developed maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

SLUICE GATES

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: flow unobstructed.
   ACT: operator looks at gates and removes any objects which block flow.
   WHY: gates may be blocked by sticks, rags, balls of grease, and other objects.

2. POSSIBLE MALFUNCTION--None

3. PREVENTIVE MAINTENANCE
   REF: sluice gate manufacturer's maintenance manual.
   FREQ: weekly.
   COND: none.
   GEN ACT:
   (a) Move gate through one cycle of closing and opening.
   WHY: to insure that gears do not freeze up.
   FREQ: annually
   COND:
   (a) Edges of gate damaged (torn or burred): seen by operator.
   ACT: lightly file edges smooth with file to remove burrs.
   (b) Gate slots filled with sediment: seen by operator.
   ACT: jet material from slots with water from high pressure hose.
   (c) Gate slots damaged (bent or burred): seen by operator.
   ACT: use file to file burrs from gate guides.
   GEN ACT:
   (a) Follow shut-down procedure for gates above and below gate being inspected in the channel in order to drain channel on both sides of gate for inspection.
   (b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.
   (c) Use grease gun to lubricate gears with proper lubricant as indicated in maintenance manual.
   WHY: too much, too little, or the wrong type of lubricant may cause damage to gears.
   (d) Clean up all spilled lubricant with rags and/or absorbent.
   (e) Follow START-UP procedure for process.
   (f) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Prevent water from squirting back on the operator when water is jetting out of the gate slots.
WHY: to prevent infection that the pathogenic organisms in the water could cause if allowed into human orifices.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

WEIRS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: effluent running evenly over clean weirs.
   ACT: operator looks at effluent flowing over weirs, washes down with high pressure hose if any solids build up is present.

2. POSSIBLE MALFUNCTION

   (a) Weir not level (effluent not flowing evenly): seen by operator.
   REF: sludge collector manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.
   WHY: if the weir is not level, short circuiting will occur causing localized high velocities and bypassing of the majority of the sedimentary basin resulting in solvents carry over.

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Any evidence of failure of protective coating: seen by operator.
   ACT: properly prepare weirs by scraping old paint off and cleaning surfaces and reapply protective coating to affected areas.
   GEN ACT:
   (a) Proceed with shut-down procedure in order to drain tank.
   (b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.
   (c) Follow start up procedure for process.
   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

BAFFLES

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: no scum behind baffle.
   ACT: operator looks at baffles and removes any accumulated scum with long handle brush.
   WHY: accumulations of scum behind baffles obstruct flow, are unsightly, and cause odors.

2. POSSIBLE MALFUNCTIONS

   (a) Baffle fastenings fail (pulled loose, rusted), causing baffle to fall to tank floor: observed by operator.
   REF: sedimentation tank manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to collector drive motor by turning control to OFF. Divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operation manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: sedimentation tank manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Fastening bolts loose: seen by operator.
   ACT: tighten bolts with wrench.

   (b) Portions of skirt cracked or missing: seen by operator.
   ACT: manually replace cracked or broken skirt panels.

   (c) Grease deposits on skirt: seen by operator.
   ACT: hose down area behind skirt under peripheral influent channel with high pressure hose.

   GEN ACT:
   (a) Drain tank by following shut-down procedure.

   (b) Enter tank using safety measures such as safety ladders, tie-downs, and slip proof boots.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Use proper ladders and safety equipment.
WHY: to prevent falls and possibly injury.

(b) Use proper size wrenches when tightening bolts.
WHY: improper wrenches could slip on bolts and cause injury.

SKIMMER TROUGH

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: skimmer trough revolves and grease and scum flows to grease pit.
   ACT: operator manually revolves trough into a position so that it will draw off the grease and scum without drawing too much water (usually a depth of 1/2 inch is sufficient); when all scum is removed, operator rotates trough to closed position so that no water will flow into trough.

2. POSSIBLE MALFUNCTIONS

   (a) Skimmer will not revolve: operator attempts to rotate trough.
   REF: sludge collector manufacturer's maintenance manual.
   IMM OP ADJ: immediately notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: sludge collector manufacturer's maintenance manual.
   FREQ: at least once every week.
   COND: none.
   GEN ACT:
   (a) Clean trough with high pressure hose.
   (b) Use grease gun to lubricate trough bearings with proper lubricant as designated by manufacturer's maintenance manual.
   (c) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

GREASE PIT

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: grease pit not full.
   ACT: operator pumps out grease pit when level is one foot below the inlet pipe.

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
   REF: plant developed maintenance manual.
   FREQ: annually.
   COND:
   (a) Build up of grease in piping: seen and felt by operator.
   ACT: clean piping by hand and rodding, then flush with high pressure hose.
   WHY: build up will reduce carrying capacity of pipe and eventually cause stop up. Prevent excessive down time to unstop piping.
   GEN ACT:
   (a) Pump out grease pit with sludge pumps.
   (b) Remove grease build up by scraping with shovels, melting with steam or cutting with high pressure spray from hose.
   WHY: grease build up will crease unsightly conditions and unpleasant odors.
   (c) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TIME CLOCK

1. NORMAL PROCEDURE
   FREQ; at least once every 8-hour shift.
   COND: clock starts and stops motor at correct times as determined by clock setting.
   ACT: operator looks at clock during ON and OFF cycle.

2. POSSIBLE MALFUNCTIONS

   (a) Clock does not start and stop motor at correct time as determined by clock setting: seen by operator.
   REF: clock manufacturer's instruction manual.
   IMM OP ADJ: perform functions (turn pump on/turn pump off) manually, refer to corrective maintenance for repair or replacement.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

FIRST AID KIT

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: first aid kit in proper place and contains proper supplies listed on inventory sheet in kit.
ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies.
WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

(a) Kit is missing: seen by operator.
IMM OP ADJ: notify supervisor and replace kit.

(b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.

3. PREVENTIVE MAINTENANCE
FREQ: at least once every week
COND:
(a) Some supplies missing: seen by operator.
GEN ACT:
(a) Operator replenishes first aid supplies by using inventory sheet in lid.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
FREQ: at least once every 8 hours.
COND: fire fighting equipment in proper place and has been inspected within the last month by plant fire marshal.
ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, notify fire marshal.
WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

(a) Equipment missing: observed by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

(b) Equipment damaged: observed by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
FREQ: annually.
COND:
(a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
GEN ACT:
(a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
WHY: low weight indicates extinguisher should be recharged.

(b) Observe pressure gage on extinguisher (dry chemical) to see that needly is pointing in position that shows pressure is not low.

(c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

AERATION

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
Technology Training Programs

U. S. Environmental Protection Agency
Office of Water Program Operations
Academic Training Branch

Clemson University
Clemson, South Carolina

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AERATION

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START-UP PROCEDURE FOR PROCESS

1. Go to aeration tank. Manually open diffuser head valves by turning valve handle to OPEN position. (Do this on one tank only; it is not necessary to do it to all tanks if there are more than one.) Returning from tank towards compressor room, manually open all valves in line.

2. Manually push STOP button on compressor and "lock out" compressor so it will not start.
   WHY: to prevent possible injury to operator by accidental start-up.

3. Inspect by observation oil level in compressor by removing oil dipstick to see if oil level indicated is FULL (as seen by film of oil on dipstick). If oil level is not FULL, add oil according to manufacturer's instructions until level indicated is FULL. Inspect again using dipstick and look at oil film left on dipstick. It should indicate FULL. If it doesn't, notify supervisor.

4. Go to electric control panel, remove red LOCK-OUT-TAG and pull lever for compressor into ON position.

5. Return to compressor. Hold STOP button in closed position, and release slowly. Inspect by observation the rotation of shaft to see if it rotates according to manufacturer's specifications. Listen for undue noise caused by improper rotation of shaft. If shaft not rotating in proper direction, notify supervisor and refer to corrective maintenance. If shaft rotating in proper direction (compressor operating while making continuous, rhythmic noise), continue as follows:

   Manually push STOP button on compressor and "lock out" compressor. Visually inspect and feel with hand if V-belts are properly aligned according to manufacturer's specifications and do not have too much tension (no slack). If drive belts are too tight or too slack, notify supervisor and refer to corrective maintenance. After inspecting, "unlock" compressor, hold STOP button in closed position, and release slowly.

6. Go to the aeration tank with open diffuser head valve and proceed as follows:
   - (a) Verify that all diffuser head valves are fully OPEN by giving a quick 1/8-turn in clockwise direction, then in counter-clockwise direction. (Handle should stop turning counter-clockwise when valve fully OPEN.)
   - (b) Inspect all pipe joints for air leaks by passing hand around joints. A stream of air from joint felt on hand will indicate a leak. Notify supervisor and refer to corrective maintenance if a leak is found.
   - (c) If no air leaks are found around pipe joints, place ladder in tank, and descend to bottom of tank. Inspect each swing header for leaks at joints and end plugs by using hand technique. Inspect each tube for air output by passing hand over its entire length. (A stream of air should be felt over the entire length.)

Continued

Start-Up Procedure for Process--Continued

7. Manually start up blower by pushing START button.

8. Go to aeration tank and manually open drop gates in distribution channel by lifting sliding gate out of channel with hands. Place gate against tank wall for temporary storage use. (Effluent from primary tank will now enter aeration tank.) While tank is filling, verify that blower is operating at all times by going to blower room and listening to blower operate. If blower is not operating, notify supervisor and refer to corrective maintenance. WHY: If blower is not operating while tank is being filled, effluent would eventually cover diffuser tubes and penetrate inside tubes, leading to poor diffusion of air in tank and replacement of tubes.

9. When aeration tank is full as seen by effluent overflowing weirs, visually inspect "rolling" action of water from one side to the other, as caused by diffused air being introduced into tank contents. If this condition does not meet characteristics designated by manufacturer's specifications, notify supervisor.

10. Inspect the blower again as follows:

    (a) Place hand on blower to determine any excessive heat. If hand gets hot very fast (within 15-20 seconds), blower is overheating. Notify supervisor and refer to corrective maintenance if this occurs.

    (b) Listen for any unusual noise as indicated by previous experience. If any unusual noises are heard, notify supervisor and refer to corrective maintenance.

    (c) Look for any unusual vibration of blower as indicated by previous experience. If any unusual vibration of blower is seen, notify supervisor and refer to corrective maintenance.

    (d) Look at V-belts to see if there is any undue slack or flapping as they turn, or if there is no slack at all. If there is, notify supervisor and refer to corrective maintenance.

    (e) Look at pressure gage on discharge pipe. Discharge air pressure should indicate 8-9 p.s.i. If this pressure is not shown, notify supervisor.

    (f) Inspect pressure relief valve in discharge line by closing diffuser head valve. Pressure relief valve should open (seen by operator) to exhaust excess pressure. Re-open diffuser head valve by turning handle to open position. Pressure relief valve should close (seen by operator) when pressure drops below set rate on relief valve. If pressure relief valve does not open or close as above, notify supervisor and refer to corrective maintenance.

11. Inspect electric motor driving blower as follows:

    (a) Place hand on motor to determine any excessive heat. If hand gets hot very fast (within 15-20 seconds), motor is overheating. Notify supervisor and refer to corrective maintenance if this occurs.

Start-Up Procedure for Process--Continued

(b) Listen to motor for unusual noise as indicated by previous experience. (Motor normally operates with even hum.) If any unusual noise heard, notify supervisor and refer to corrective maintenance.

(c) Look for any unusual vibration of motor as indicated by previous experience. If any unusual vibration is seen, notify supervisor and refer to corrective maintenance.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Pick up drop gates temporarily stored near tank and slide into slots provided in primary effluent distribution channel.

2. Manually open sludge plug (or drain valve) in bottom of aeration tank by turning handle to OPEN position.

3. When level of wastewater in tank has dropped below diffuser tubes, manually shut off air supply quickly by closing diffuser head valve.
   WHY:
   (a) If air supply not shut off quickly, air supply to other aeration tanks in operation will be depleted.
   (b) Air supply to diffusers must be left in operation until wastewater level has dropped below diffuser tubes to prevent seepage of sludge into tubes thus blocking perforated holes in tubes and reducing distribution efficiency of diffuser tubes. Tubes would have to be replaced should this occur.

4. Use high pressure hose to hose down tank walls, diffuser tubes and headers as wastewater level continues to drop.

5. Manually shut off blower by pushing OFF button.

6. Manually push STOP button on compressor and "lock out" compressor. Manually pull lever for compressor into OFF position on electric control panel.

7. When wastewater level has dropped to approximately 6 inches from floor level, place ladder in aeration tank, descend into tank with hose and squeegee. Hose and squeegee floor until there are no more accumulations of sludge on floor and floor is clean.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

Component/Step	Frequency
1. Indicator Lights	every 8 hours
2. Blowers	" " "
3. Motors (Blower motor and Pump motor)	every 4 hours
4. Indicator Gages	every 8 hours
5. Header	" " "
6. Valves (Gate, Drop Gate)	" " "
7. Pumps (Piston type-belt driven)	every 4 hours
8. Manometers (U-Tube)	every 8 hours
9. First Aid Kit	" " "
10. Fire Fighting Equipment	" " "
11. Foam Spray System	every 4 hours
12. Diffuser Tubes	" " "

GENERAL ORDER FOR PREFORMING PREVENTIVE MAINTENANCE PROCEDURE

Component/Step	Frequency
1. Blowers	annually
2. Motors (Blower motor and Pump motor)	monthly
3. Valves (Gate, Drop Gate)	monthly
4. Pumps (Piston type-belt driven)	weekly/semi=annually/annually
5. First Aid Kit	weekly
6. Fire Fighting Equipment	annually
7. Foam Spray System	as required

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Color

    (a) Black: seen by operator.
    CAUSE:
    (1) Waste has turned septic because:
        a. of shock load of toxic materials introduced into collection system.
        b. of sludge load of domestic sewage introduced into collection system.
        c. of *insufficient* detention time (less than indicated in operation plant manual).
        d. of *insufficient* air supply to aeration tank. (Minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)
        e. return sludge rate is too slow.
        f. collectors in final clarifier are plugged.

    (b) Any color not normal for a particular plant (determined by entries of abnormalities in plant operations log): seen by operator.
    CAUSE:
    (1) Unusual industrial waste being introduced into collection system.

2. Odor

    (a) Unpleasant, septic odor: smelled by operator.
    CAUSE:
    (1) *Insufficient* air (under-aeration) to aeration tank. (Minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)

3. Frothing

    (a) Buildup of foam on aeration tank: seen by operator.
    CAUSE:
    (1) Carrying a low suspended solids concentration during normal operation.
    (2) Low suspended solids concentration caused by heavy rains.
    (3) Low suspended solids concentration caused by industrial chemicals in the influent.
    (4) A change in the return sludge rate.
    (5) Detention time too long in the primary sedimentation tank(s).

Continued

4. pH

   (a) pH of waste is HIGH as indicated on pH meter when electrodes of pH meter placed in sample (reading on pH meter above 8.5): seen by operator.
   CAUSE:
   (1) Waste has turned septic because of shock load of strong alkaline wastes introduced into collection system.

   (b) pH of waste is LOW as indicated on pH meter when electrodes of pH meter placed in sample (reading on pH meter below 6.5): seen by operator.
   CAUSE:
   (1) Waste has turned septic because of shock load of strong acid wastes introduced into collection system.

5. Bulking--in Secondary Sedimentation Tank

   (a) Sludge blanket in secondary sedimentation tank rises to surface and flows over weirs with effluent: seen by operator.
   CAUSE:
   (1) High or excessive flow (rain).
   (2) Septic condition due to insufficient air (insufficient air is insufficient oxygen in tank; minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.).
   (3) Septic condition due to industrial wastes.
   (4) Septic condition due to mechanism in final tank being inoperative.
   (5) Waste has turned septic because:
      a. of shock load of toxic materials introduced into collection system.
      b. of sludge load of domestic sewage introduced into collection system.
      c. of insufficient detention time (detention time less than indicated in plant operation manual).
      d. of insufficient air supply to aeration tank (Insufficient air is actually insufficient oxygen in tank; minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.).
      e. return sludge rate is too slow.
      f. collectors in final clarifier are plugged.

6. Dissolved Oxygen

   (a) Lack of dissolved oxygen (observed by results from lab test): seen by operator.

Continued

CAUSE:
(1) Insufficient oxygen due to too high suspended solids in aeration tank. (Minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)

(2) Insufficient oxygen due to industrial wastes entering aeration tank. (Minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)

(3) Insufficient air--too high a load. (Insufficient air is actually insufficient dissolved oxygen in tank; minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)

(4) Insufficient air due to plugged diffusers. (Insufficient air is actually insufficient dissolved oxygen in tank; minimum dissolved oxygen required is 1-2 mg/l in all parts of aeration tank.)

7. Suspended Solids

(a) LOW suspended solids (indicated by excessive foam in aeration tank): seen by operator.
CAUSE:
(1) Return sludge rate too low.
(2) Return sludge pump stopped.
(3) Collector mechanism in final tank stopped.

(b) Too HIGH suspended solids (color of sludge very dark, chocolate color): seen by operator.
CAUSE:
(1) Insufficient wasting to primary tank (return rate too LOW).
(2) Insufficient detention time in primary tank (detention time less than indicated in plant operation manual).
(3) Broken mechanism in primary tank.
(4) Sudden surge of organic waste into plant.

8. Foam

(a) Foam and soap bubble appearance: seen by operator.
CAUSE:
(1) Excessive chemical wastes from soap suds, detergents.
(2) Low suspended solids.

9. Volume

(a) HIGH: seen by operator
CAUSE:
(1) Sudden rainfall.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

COMPOSTING A SAMPLE

1. The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, influent composite sample for 8:00 a.m.--4:00 p.m. shift would be as follows:

Time Taken	Flow Rate, MGD	Volume of Sample, mℓ
10:00 a.m.	7.0	700
12:00 N	6.5	650
2:00 p.m.	6.0	600
4:00 p.m.	5.5	550
	Total Shift Sample	2500 mℓ

In the above example, 100 mℓ of sample were taken for each 1 MGD flow rate. Determination of this sample volume to flow rate ratio is as follows:

(a) Obtain from laboratory the total volume of sample needed to conduct tests for 24-hour period (assume 6 ℓ/day).

(b) Determine the number of samples to be taken in a 24-hour period (assume one every two hours).

$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed (from part (a) above) by the number of samples to be taken (from part (b) above) to obtain the average volume needed for each sample:

$$\frac{6\ \ell}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5\ \ell}{\text{sample}}$$

(d) Divide the average volume per sample (from part (c) above) by the average daily flow of wastewater through the plant (assume 5 MGD).

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5 \text{ MGD}} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}}$$

(e) Multiply the sample volume per 1 MGD (from part (d) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD):

$$10{:}00 \text{ a.m. sample} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}} \times 7.0 \text{ MGD} = 0.70\ \ell = 700 \text{ m}\ell$$

WHY: A composite sample will give a more accurate representation than a grab sample, because the wastestream characteristics are continually changing as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed.

Continued

NORMAL SAMPLING

1. *Composite--influent*

   FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
   ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream enters the aeration tank. When dipping sample, use care that the channel side walls are not touched and large chunks of material are not included in the sample. Pour into a clean container, cap and immediately place in laboratory refrigerator.
   WHY: large solids or material scraped from the side wall will not give a representative sample of the influent.

2. Composite--effluent

   FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
   ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream leaves the aeration tank. When dipping sample, use care that the channel side walls or weir are not touched and large chunks of material are not included in the sample. Pour into a clean container, cap, and immediately place in laboratory refrigerator.
   WHY: large solids or material scrapped from the side wall will not give a representative sample of the effluent.

MAJOR SAFETY FACTORS

1. Prevent splashing of sewage into eyes or body openings.
   WHY: pathogenic organisms that abound in sewage water can cause infection if induced into openings.

2. Wash hands after taking sewage samples.
   WHY: organisms may be introduced into the body by careless sanitary practices.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTORS (Blower Motor and Pump Motor)

1. NORMAL PROCEDURE:
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate, free of vibration, running with normal even humming sound, shaft turning, and bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen and/or heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switchgear. If, when reset, motor won't run manually, turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

   (b) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; refer to corrective maintenance and notify supervisor.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (f) Smoke rising out of casing: seen and/or smelt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; refer to corrective maintenance.

Continued

Motors (Blower Motor and Pump Motor)

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:

(1) Manually turn control switch OFF.

(2) Tighten connections with screwdriver.

(3) Manually turn control switch ON.

WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a damgerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON; manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment. WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent. WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach. WHY: to prevent falls and resulting injury.

BLOWERS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: blower only warm, running with even hum, free of vibration, shaft turning, V-belts turning with little jumping.
   ACT: operator feels motor attached to blower for vibrations and heat, listens for unusual sounds, looks at V-belt turning.

2. POSSIBLE MALFUNCTIONS

   (a) Unusual noise: heard by operator.
   REF: blower manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (b) Blower too hot (cannot hold hand firmly on blower casing for at least 15 seconds): felt by operator.
   REF: blower manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: blower manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to blower motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (d) Blower stopped (shaft not turning): seen by operator.
   REF: blower manufacturer's maintenance manual.
   IMM OP ADJ: operator manuall resets power source over load protection device by pressing reset button in switch gear. If, when reset, motor won't run manually, turn power to motor to OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

3. PREVENTIVE MAINTENANCE
   REF: blower manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) V-belts frayed or cracked: seen by operator.
   ACT: refer to corrective maintenance.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Drain old lubricant in bearing box by pulling out plug in bottom and draining lubricant into container.

(d) Replace plug in bottom and replenish with proper amount of correct lubricant according to manufacturer's specifications.
WHY: wrong lubricant and too much or too little lubricant will damage bearings.

(e) Clean up all excessive or spilled lubricant using rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

MANOMETERS (U-TUBE)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: mercury in one leg of U-Tube is higher (or lower) than in other leg; pressure reading seems normal for situation as compared from previous experience.
   ACT: operator looks at device, takes reading, compares with previous readings to determine if any wide variations. If any wide variations, operator notifies supervisor.

2. POSSIBLE MALFUNCTIONS

   (a) Mercury level is same in both manometer legs: seen by operator.
   REF: manometer manufacturer's maintenance manual.
   IMM OP ADJ: manually close isolation gate valve on manometer and notify supervisor.

   (b) Gage showing wide variation in readings: seen by operator.
   REF: manometer manufacturer's maintenance manual.
   IMM OP ADJ: manually turn blower motor control switch to OFF and notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

PUMPS (Piston Type-Belt Driven)

1. NORMAL PROCEDURE

   FREQ: at least once every 4 hours.

   COND: automatic oiler is full of clean oil; oiler on eccentric strap dripping at normal rate (determined by specifications of equipment). Water supply to packing flowing enough to lubricate piston without excessive waste of water. (A permanent reservoir of heavy oil is sometimes used instead of water.) Drive belt tension approximately one inch slack with pump OFF, normal pumping rate shown on: flow meter, pump discharge pressure, pump motor ammeter, or combination of these. Starts pumping at the desired pressure with no unusual noises or vibrations as determined by previous experience. No leaking.

   ACT: operator visually observes oiler, piston water supply, supernatant flow, and digester gas pressure manometer. Operator also looks at pump for leaks and listens for any unusual noises. Fills automatic oiler with proper oil designated by manufacturer's maintenance manual, and manually turns automatic oiler on when starting pump; operator looks and listens for any unusual vibrations.

2. POSSIBLE MALFUNCTIONS

   (a) Sludge leaking around piston: seen by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: tighten each packing follower nut approximately 1/8 turn with pump running, and visually observe packing. Adjust packing in small increments until leak stops. If packing will not seal properly without binding piston,(indicated by heat generated in packing gland), notify supervisor and refer to corrective maintenance for repacking.

   (b) Lower than normal discharge pressure (indicated on discharge pressure gage): seen by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump drive motor, close suction and discharge valves, drain ball check chambers to reduce pressure, remove ball check chamber covers and inspect for sticks, rags, and other debris that might be keeping the ball checks from seating properly (determined by previous experience). Remove debris with hand, replace ball check chamber covers, manually open valves and manually turn power to pump drive motor ON.

   (c) Packing too tight: seen by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump drive motor. Loosen packing follower nuts 1/2 turn, restart pump by manually cutting power to pump drive motor ON.
   WHY: packing that is too tight can cause excessive wear on eccentric and strap, scoring of piston, sheared pins, or even cracked cylinder. (Note: never tighten the eccentric body and flange so tight that the pin would not shear if the pump jammed or was overloaded.)

(d) Eccentric strap heats up: seen and/or smelled by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.
WHY: any one or combination of the above will increase friction on the strap and create heat.

(e) Loose drive belts: seen and/or heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.
WHY: loose belts cause excessive wear to belts and pulleys.

(f) Suction line plugged (visual observation of suction pressure gage): seen by operator.
REF: plant operation manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(g) Pump running but no sludge is being discharged and/or discharge pressure gage shows no pressure: sludge seen and gage read by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(h) Pump leaking (excessive amount of water around gland): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(i) Pump pulley turning but piston not working: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(j) Motor running but pump pulley not turning: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

Pumps (Piston Type-Belt Driven)--Continued

(k) Pump knocking or making unusual noise: heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(l) Motor not running: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Frayed, slack, or cracked belt: seen by operator as he presses belt.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Observe oil in gear box for proper amount by looking at sight gage or dipstick; add oil if necessary.

(d) Clean up any spilled oil with rags and/or absorbent.

(e) Use allen wrench to tighten screws in pulley.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to UTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Remove drain plug with wrench and completely drain old oil.

(c) Replace drain plug with wrench and fill to "full" level on gage with proper oil as designated by the manufacturer's maintenance manual.

(d) Manually remove gear box cover, look for worn teeth (teeth not meshing at least one quarter of an inch) and broken (cracked) teeth. Determine, by trying to move with hand, if gears are loose on shaft (if loose, tighten with allen wrench).

(e) Manually replace gear box cover.

(f) Fill the gear box to the correct level (indicated by previous experience or by markings on box) with the proper oil designated by the manufacturer's maintenance manual.

(g) Clean up any spilled oil with rags and/or absorbent.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON (HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: annually.
COND:
(a) Plunger piston worn or scored (excessive leaking at packing gland): seen by operator.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually close suction and discharge valves and drain pump before opening pump case.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Manually remove ball checks, accurately determine wear as pointed out in pump manufacturer's maintenance manual; if wear is excessive, refer to corrective maintenance for replacement.

(e) Visually inspect ball seats for cracks or broken places. Repair if necessary as indicated by manufacturer's maintenance manual.

(f) Visually inspect upper bearing and eccentric strap clearances. Restore to manufacturer's specifications as indicated by specifications if conditions are not up to conditions in specifications.

(g) Manually close pump case and manually open suction and discharge valves.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Manually close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent possible injury to operator.

VALVES (Gate, Drop Gate)

1. NORMAL PROCEDURE

FREQ: at least once every 8 hour shift.
COND: valve(s) that should be open is open, valve(s) that should be closed is closed (valve positions to be obtained from supervisor).
ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

(a) Handle frozen (operator tries to move handle): felt by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Broken stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(c) Leaking around stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(d) Valve turns hard: felt by operator (tries to turn valve).
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(e) Valve turns easily but won't close completely: seen and felt by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE

REF: valve manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:

(a) Wipe old grease from valve stem with rags.

(b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.

(c) Use the proper size and type of valve handle to move valve through one complete cycle (completely open then completely closed); if it does not completely open (close), refer to corrective maintenance.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Use the proper size and type of valve handle when turning valves. WHY: improper type valve handle may slip and cause injury to the operator.

DIFFUSER TUBES

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: air bubbles rising along entire length of one wall of tank, giving rolling motion to tank contents.
   ACT: operator looks to see that rolling motion is continuous along entire length (that no "dead spots" exist).

2. POSSIBLE MALFUNCTIONS

   (a) Diffuser tube(s) plugged (indicated by "dead spot" or excessive bubbles in one area): seen by operator.
   REF: diffuser tube manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (b) Diffuser blows off header (indicated by excessive "hill" of large bubbles in local area): seen by operator.
   REF: diffuser tube manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (c) Nylon wrapping around diffuser becomes loose (indicated by concentration of bubbles in local area): seen by operator.
   REF: diffuser tube manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS

   (a) Observe plant safety rules when working on shoulder of open tank.
   WHY: to prevent injury or death to operator.

FOAM SPRAY SYSTEMS

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: spray coming from each nozzle overlap each other. Spray hits the water approximately two or three inches from aeration tank wall.
   ACT: operator looks at spray coming from each nozzle; visually inspects whether the spray hits the water approximately two or three inches from aeration tank wall.

2. POSSIBLE MALFUNCTIONS

   (a) Nozzle becomes plugged, preventing any spray: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

   (b) Water pressure from nozzle is insufficient (water spray not overlapping and not hitting water two or three inches from aeration tank wall): seen by operator.
   REF: plant maintenance manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: nozzle manufacturer's maintenance manual; plant maintenance manual.
   FREQ: as required.
   COND: none.
   GEN ACT:
   (a) Manually close inlet valve on foam spray system.

   (b) If only ONE aeration tank, shut down water pump for Foam Spray System by manually turning pump motor control switch to OFF; padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment. (If more than ONE aeration tank, water pump is left operating to supply water to foam spray systems in other tank(s).)

   (c) Visually inspect spray nozzles for excessive dirt, or wear, refer to corrective maintenance for repair.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

INDICATOR LIGHTS

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: indicator light on electric panel is ON (OFF) indicating that component is operating (not operating); component is actually operating (not operating). Indicator light (red or green) comes on (goes off) when operator turns control switch to ON (OFF).
   ACT: operator visually inspects and turns control switch to ON (or OFF) position. In so doing, operator verifies that indicator light (red or green) comes on (off); operator visually observes component running (not running) when turns control switch to ON (OFF).

2. POSSIBLE MALFUNCTIONS

   (a) Red (or green) light does not light up when operator turns control switch to ON (OFF) position: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually turn control switch to OFF(ON). Change indicator light and again turn to ON(OFF). If light still not working, turn OFF control switch and notify supervisor.

3. PREVENTIVE MAINTENANCE--None.

4. MAJOR SAFETY FACTORS

   (a) Manually turn off control switch when changing light.
   WHY: to prevent injury or death to operator due to electrical shock.

   (b) Observe plant safety rules.
   WHY: to prevent injury or death to operator.

INDICATOR GAGES

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: gages indicate air pressure reading when blower is operating. Needle on gages "bounces" slightly but consistently.
   ACT: operator visually inspects gage reading for previous conditions.

2. POSSIBLE MALFUNCTIONS

   (a) Indicator gage broken (no movement of needle): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually shut stop valve to gage and notify supervisor.

   (b) Indicator gage dial not showing any pressure reading while blower is operating: seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: look at stop valve to gage to see if it is closed; if it is closed, manually open stop valve. If it is open, notify supervisor. If gage dial still reading zero and if valve needed to be opened, notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS--None

HEADER

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: air from blower to diffusers in aeration tank flowing without any hissing sounds or visual indications of leaks.
   ACT: operator visually inspects header for leaks and listens for unusual hissing sound (indicating air leak).

2. POSSIBLE MALFUNCTIONS

   (a) Unusual hissing sound: heard by operator.
   REF: plant maintenance manual.
   IMM OP ADJ: determine exact location of hissing and mark the leak; manually shut down air blower. Notify supervisor.

   (b) Unusual (indicated by previous experience) bubbling action in aeration tank: seen by operator.
   REF: plant maintenance manual.
   IMM OP ADJ: manually shut down air blower and notify supervisor.

3. PREVENTIVE MAINTENANCE--None

4. MAJOR SAFETY FACTORS

   (a) Observe plant safety rules.
   WHY: to prevent injury or death of operator.

FIRST AID KIT

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hour shift.
   COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed on inventory sheet in kit.
   ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies.
   WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

   (a) Kit is missing: seen by operator.
   REF: first aid kit manual
   IMM OP ADJ: notify supervisor.

   (b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
   REF: first aid kit manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: first aid kit
   FREQ: at least once every week.
   COND:
   (a) Some supplies missing: seen by operator.
   ACT: determine actual amount of supplies missing.
   GEN ACT:
   (a) Replenish first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.
   (b) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
FREQ: at least once every 8 hours.
COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshal.
ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

(a) Equipment missing: seen by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

(b) Equipment damaged: seen by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: fire fighting maintenance manual.
FREQ: annually.
COND:
(a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: seen and felt by operator.
ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
GEN ACT:
(a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
WHY: low weight indicates extinguisher should be recharged.

(b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is not low.

(c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None.

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

SECONDARY SEDIMENTATION

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
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U. S. Environmental Protection Agency
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SECONDARY SEDIMENTATION

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START-UP PROCEDURE FOR PROCESS

1. Inspect tank and peripheral channel prior to start-up as follows:
    (a) Verify by observation that tank and channel are free of tools, ladders, debris. (Remove items if necessary.)

    (b) Inspect each moving component of unit to verify that collector drive motor, gear reducer, drive gears, sweep arms, return pump motor, variable speed drive, coupling, pumps, and telescopic valve are free of tools and debris. (Remove if necessary.)

    (c) Verify by observation that all personnel are clear of unit and are aware of start-up. (Inform any personnel if necessary.) WHY: to prevent personnel injury and prevent mechanical damage to unit.

    WHY: to prevent personnel injury and prevent mechanical damage to unit.

2. Verify that the sweep-collector is operational as follows:
    (a) Start motor by turning control switch to ON.

    (b) Verify by observation that the motor, gear reducer, and sweep-collectors are moving smoothly and quietly. *If any component is not functioning properly, refer to corrective maintenance before proceeding.*

    (c) Stop unit by turning control switch to OFF.

3. Put secondary sedimentation on line as follows:
    (a) Close drain valve by turning handle clockwise.

    (b) Place telescopic valve in UP position by turning control handle fully clockwise.

    (c) Manually pull inlet gate up to one eighth open.

    (d) Allow water to flow until sweep arms are covered. Close inlet slide gate by pushing down until flow stops.

    (e) Start sweep drive by turning motor control switch to ON.

    (f) Observe operation of sweeps for one full revolution. *If any components listed in 2(b) are not functioning properly, refer to corrective maintenance before proceeding.*

    (g) Open inlet gate one quarter by pulling up slide gate to continue filling tank. Manually adjust filling rate to that parallel units will maintain their operational level.

    (h) When tank is full, manually open inlet gate fully and start sprays by turning valve counter clockwise.

4. Put sludge return pump on the line as follows:
    (a) Verify that the pump drain valve is closed by turning valve handle fully clockwise.

Continued

(b) Verify that pump suction and discharge valves are open by turning valve handle fully counter clockwise.

(c) Bleed the air from the pump by opening the bleed-off petcock until water appears.

(d) Manually release LOCK-OUT-STOP switch.

(e) Start pump by moving motor control switch to ON.

(f) Observe packing seal water rotometer for flow indication and packing for slight drip of water.

(g) Verify by observation that motor, variable speed drive, coupling, and pump operate smoothly and produce no unusual sounds. *If any component is not functioning properly, refer to corrective maintenance before proceeding.*

(h) Adjust pumping rate by increasing or decreasing output of controller as indicated in supervisor's instructions.

(i) Verify by observation of the pump discharge flow that the pump is pumping.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Put alternate unit into service.
2. Install sedimentation tank inlet gate in guide slots by using overhead crane and manually push down until flow stops.
3. Continue sludge pumping rate by increasing or decreasing output of controller.
4. Turn sprayers off by turning control valve clockwise.
5. By using high pressure hose, hose peripheral feed channel, tank walls, and equipment as tank is draining.
6. Continue sludge pumping until the bulk of solids are removed from the sedimentation tank as indicated by a clearing of the flow over the sludge weir.
7. Turn sludge pump off by turning control switch to OFF.
8. Turn sweep-collector off by turning control switch to OFF and open the electrical disconnect switch. Lock in the OFF position and tag before proceeding.
   WHY: to prevent injury to personnel and prevent possible mechanical damage.
9. Open the sedimentation tank drain valve by turning the drain valve handle counter clockwise.
10. Continue to hose the tank walls, piping, sweep arms, and tank bottom until all the sludge is removed.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

	Component/Step	Frequency
1.	Motor (Sweep Collector Drive)	every 4 hours
2.	Speed Reducer (Sweep Collector Drive)	" " "
3.	Shear Pin and Alarm Trigger	" " "
4.	Sweep Collectors	" " "
5.	Motor (Secondary Sludge Pump)	" " "
6.	Variable Speed Drive (Secondary Sludge Pump)	" " " " "
7.	Coupling (Secondary Sludge Pump)	" " "
8.	Secondary Sludge Pump (Centrifugal)	" " "
9.	Skimming Device (Telescopic Valve)	every 8 hours
10.	Weirs (Effluent)	" " "
11.	Inlet Gate	" " "
12.	Surface Skimming Sprays	" " "
13.	Drain Valve	" " "
14.	Secondary Sludge Weir	" " "
15.	Sludge Depth Samples	" " "
16.	Influent Sampling	" " "
17.	Effluent Sampling	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

1.	Variable Speed Drive (Secondary Sludge Pump)	weekly
2.	Secondary Sludge Pump (Centrifugal)	weekly/semi-annually
3.	Motor (Sweep Collector Drive)	monthly
4.	Sweep Collectors	monthly/annually
5.	Motor (Secondary Sludge Pump)	monthly
6.	Skimming Device (Telescopic Valve)	"
7.	Surface Skimming Sprays	"
8.	Drain Valve	"
9.	Secondary Sludge Weir	"
10.	Coupling (Secondary Sludge Pump)	semi-annually
11.	Speed Reducer (Sweep Collector Drive)	" "
12.	Shear Pin and Alarm Trigger	" "
13.	Baffles (Skirt, Submerged)	annually
14.	Weirs (Effluent)	"
15.	Inlet Gate	"
16.	Sludge Depth Samples	"

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Scum

   (a) Small, floating particles: seen by operator.
   CAUSE:
   (1) Inadequate removal of grease in preceding treatment units.
   (2) Inadequate removal by secondary sedimentation skimming sprays.

   (b) Heavy foamy scum in peripheral channel or on tank surface: seen by operator.
   CAUSE:
   (1) Excessive sludge age.
   (2) Solids concentration too high.

2. Color

   (a) Milky (yellow-green to white): seen by operator.
   CAUSE: lack of dissolved oxygen in previous treatment units.

3. Sludge

   (a) Rising black sludge: observed by operator.
   CAUSE: sludge has remained in unit too long and has turned septic.

   (b) Rising brown sludge: observed by operator.
   CAUSE:
   (1) Entrained air bubbles have floated sludge to surface.
   (2) Denitrification produces nitrogen gas which floats sludge to surface.

   (c) Bulking (activated sludge plant, billowing sludge): observed by operator.
   CAUSE: process out of balance (wrong kind of organisms present, high carbohydrate content).

   (d) Excessive solids in unit effluent: observed by operator.
   CAUSE:
   (1) Hydraulic overload washing solids over weirs.
   (2) Over-oxidation in previous unit causing pinpoint floc.
   (c) Bulking sludge.

Continued

Abnormals and Probable Causes for Process--Continued

4. Water Surface Level

   (a) Too low (lower than level during normal operations): observed by operator.
   CAUSE:
   (1) Removal through sludge pumps or scum skimming devices exceeds influent.
   (2) Drain valve open.

5. Sludge Level in Sedimentation Tank

   (a) Too high (higher than level during normal operations): observed by operator.
   CAUSE:
   (1) Inadequate sludge removal rate.
   (2) Hydraulically overloaded causing turbulence.
   (3) Process out of balance.

   (b) Too low (lower than level during normal operations): observed by operator.
   CAUSE:
   (1) Excessive sludge pumping rate.
   (2) Low volume of solids in system.
   (3) Excessively dense sludge in system.

6. Odor

   (a) Strong sour (acid, vinegar odor) or sweet odor: smelled by operator.
   CAUSE: unbalanced process (wrong kind of organisms).

   (b) Rotten egg odor: smelled by operator.
   CAUSE: septic sludge generating hydrogen sulfide.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

COMPOSITING A SAMPLE

1. The volume of sample taken must correspond to the flow rate at the time the sample is taken. For example, influent composite sample for 8:00 a.m.--4:00 p.m. shift would be as follows:

Time Taken	Flow Rate, MGD	Volume of Sample, mℓ
10:00 a.m.	7.0	700
12:00 N	6.5	650
2:00 p.m.	6.0	600
4:00 p.m.	5.5	550
	Total Shift Sample	2500 mℓ

In the above example, 100 mℓ of sample were taken for each 1 MGD flow rate. Determination of this sample volume to flow rate ratio is as follows:

(a) Obtain from laboratory the total volume of sample needed to conduct tests for 24-hour period (assume 6 ℓ/day).

(b) Determine the number of samples to be taken in a 24-hour period (assume one every two hours).

$$1 \text{ day} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{1 \text{ sample}}{2 \text{ hr}} = 12 \text{ samples}$$

(c) Divide the total volume of sample needed (from part (a) above) by the number of samples to be taken (from part (b) above) to obtain the *average* volume needed for each sample:

$$\frac{6\ \ell}{\text{day}} \times \frac{\text{day}}{12 \text{ samples}} = \frac{0.5\ \ell}{\text{sample}}$$

(d) Divide the average volume per sample (from part (c) above) by the average daily flow of wastewater through the plant (assume 5 MGD).

$$\frac{0.5\ \ell}{\text{sample}} \times \frac{1}{5 \text{ MGD}} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}}$$

(e) Multiply the sample volume per 1 MGD (from part (d) above) by the flow rate through the plant at the time of sampling (assume 10:00 a.m. flow rate is 7.0 MGD).

$$10{:}00 \text{ a.m. sample} = \frac{0.1\ \ell/\text{sample}}{1 \text{ MGD}} \times 7.0 \text{ MGD} = 0.70\ \ell = 700 \text{ m}\ell$$

WHY: A composite sample will give a more accurate representation than a grab sample because the wastestream characteristics are continually changing as to composition and rate of flow. Samples must be refrigerated to retard biological action until laboratory tests can be performed.

Continued

NORMAL SAMPLING

1. Composite--Influent

   FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
   ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream enters the clarifier. When dipping sample, use care that the channel side walls are not touched and large chunks of material are not included in the sample. Pour into a clean container, cap and immediately place in laboratory refrigerator.
   WHY: large solids or material scraped from the side wall will not give a representative sample of the influent.

2. Composite--Effluent

   FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
   ACT: using a clean sampling apparatus, dip sample from wastestream at the point the wastestream leaves the clarifier. When dipping sample, use care that the channel side walls are not touched and large chunks of material are not included in the sample.
   WHY: large solids or material scraped from the side wall will not give a representative sample of the influent.

3. Composite--Sludge

   FREQ: one sample every 8 hours composed of parts at each interval in the 8-hour period as indicated by the lab.
   ACT: using a clean sampling apparatus, dip sample from wastestream at the sludge measuring weir. When dipping sample, use care that the channel side walls or weir are not touched and large chunks of material are not included in the sample. Pour into a clean container, cap, and immediately place in laboratory refrigerator.
   WHY: large solids or material scraped from the side wall will not give a representative sample of the influent.

4. Grab--Influent

   FREQ: once per 8-hour shift.
   ACT: using clean container of at least 2 liters capacity, dip sample from wastestream at the point the wastestream enters the clarifier. Avoid scraping channel walls. Deliver sample to laboratory immediately.

5. Grab--Effluent

   FREQ: once per 8-hour shift.
   ACT: using a clean container of at least 2 liters capacity, dip sample from wastestream at the point the wastestream leaves the clarifier. Avoid scraping walls or floors of channel. Deliver sample to laboratory immediately.

Continued

6. Grab--Sludge

   FREQ: once per 8-hour shift.
   ACT: using a clean container of at least one liter capacity, dip a sample of the wastestream where it overflows the measuring weir. Avoid scraping the weir or walls. Deliver sample to the laboratory immediately.

MAJOR SAFETY FACTORS

1. Prevent splashing of sewage into the eyes or other body openings.
   WHY: pathogenic organisms that abound in sewage water can cause infection.

2. Wash the hands after taking sewage samples.
   WHY: organisms can be introduced into the body by careless sanitary practices.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTOR (Sweep Collector Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate (hold hand 30 seconds--use experience as guide); running with normal sound (low, even hum); shaft turning; and bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to ON (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearings for vibration and heat.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Thermometer shows temperature above ambient plus datum rise: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (d) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(e) Excessive vibration: seen or felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(f) Unusual noise: heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(g) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: tighten motor mounts bolts with wrench.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint or black stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

(c) Electrical connections loose or frayed: seen by operator.
ACT: refer to corrective maintenance.
WHY: loose or frayed wires may cause a fire hazard.

GEN ACT:

(a) Manually turn sweep collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Use ladder and harness when preventive maintenance is at a high (deep) position or other dangerous position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

(e) Use grease gun to apply proper amount and type of lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sweep collector drive motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn sweep collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

SPEED REDUCER (Sweep Collector Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: oil level gage shows oil within marked gage levels. No oil or grease on housing, gears running at normal noise level (low, even hum). Heat is in normal range (no smell, smoke).
   ACT: visually observe quantity of oil on gage and in housing. Add proper oil as indicated on name plate if necessary. Listen to gear sounds and observe any smoke or smell.
   WHY: low oil level will cause excessive wear on gears. Proper type of oil is necessary to long life and smooth operation.
   COND: look for minor leak (a few drops of oil on floor, a small puddle).
   ACT: record, wipe up, and observe over a period of time to determine urgency of repairs needed.

2. POSSIBLE MALFUNCTIONS

   (a) Turning gear makes unusual noise: heard by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Major leak of oil (oil puddle under gear box and/or thick film of oil on housing): seen by operator.
   REF: manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Manually turn sweep collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment (gears, drive shaft, other parts of component).

Continued

(b) Replace oil as follows:
  (1) Remove drain plug with wrench and drain old oil into container.
  (2) Flush with new oil.
  (3) Replace plug with wrench and fill with proper type oil as indicated by manufacturer's maintenance manual.

WHY: to remove inpurities with old oil and accumulated foreign matter; addition of proper type oil is necessary to long life of gears.

(c) Clean area of oil spillage or leakage with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sweep collector drive motor motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn sweep collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean area of oil spillage or leakage with rags and/or absorbent.
WHY: reduces chances of operator slipping and falling.

SHEAR PIN AND ALARM TRIGGER

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: the drive flanges are turning together at the speed indicated by the plant developed operational manual; the shear pints are not broken and are in the proper positions (in slots with breaking point at interface of flanges); the trigger arm is in the cocked position; the trigger arm is clearing the alarm switch lever by an estimated 1/8 inch.
   ACT: operator verifies the preceding conditions by visual observation.
   WHY: a broken shear pin will allow the drive flange to turn without turning the driven flange; an improperly positioned shear pin may be loose and either fall out or not shear at the proper position; correct positioning of trigger arm is necessary to activate the alarm switch during a drive flange malfunction which will send a remote alarm indication.

2. POSSIBLE MALFUNCTIONS

(a) Drive flange and driven flange not turning together while remote alarm being sent: seen and heard by operator.
REF: collector drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Drive flange and driven flange turning together while remote alarm being sent (trigger arm is out of adjustment): seen and heard by operator.
REF: collector drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(c) Shear pin is working its way out of the flange holes: seen by operator.
REF: collector drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(d) Broken shear pin: seen by operator.
REF: collector drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: to prevent the drive flange from turning when the driven flange is not turning.

Continued

(e) Improperly positioned shear pin: seen by operator.
REF: collector drive manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to collector drive motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.
WHY: to prevent pin from falling out or not shearing at proper torque.

3. PREVENTIVE MAINTENANCE
REF: collector drive manufacturer's maintenance manual.
FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Brace flanges as indicated in plant developed operational manual.
WHY: the bar rakes are heavy and may turn the drive chains a short distance when a shear pin is removed even though the power to the drive motor is in OFF position.

(c) Manually loosen set screw with allen wrench and remove shear pin.

(d) Clean flange faces with rag or wire brush and coat faces with oil or grease.
WHY: the flanges may rust or seize together allowing excessive torque to be applied to the sweep drive.

(e) Replace shear pin and tighten set screw with allen wrench.

(f) Clean area of oil spillage or grease with rags and/or absorbent.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn collector drive motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn collector drive motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean area of oil spillage or grease with rags and/or absorbent.
WHY: reduces chances of operator slipping and falling.

SWEEP COLLECTORS

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: spur and pinion gears moving smoothly. No unusual noises.
ACT: visually observe rotation of spur and pinion gears. Listen to gear sounds.
WHY: jerky movement indicates abnormal operation that must be corrected to prevent major damage.

2. POSSIBLE MALFUNCTIONS

(a) Turning gear makes unusual noise: heard by operator.
REF: sweep collector manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sweep drive by turning control switch to OFF. Divert flow to alternate unit by rearranging gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) Turning gear jerks and jumps: observed by operator.
REF: sweep collector manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sweep drive by turning control switch to OFF. Divert flow to alternate unit by rearranging gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: sweep collector manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:

(a) Manually turn sweep collector motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before preforming any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Swab recommended lubricant with rag on exposed pinion and spur gear.
WHY: to prevent rust and promote smooth operation of gears.

(c) Lubricate with grease gun shaft bearings with proper amount and type lubricant as called for in manufacturer's maintenance manual.
WHY: to prevent wear on bearing surfaces; wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sweep collector motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: annually.
COND: none.
GEN ACT:

(a) Drain and clean tank by following SHUT-DOWN PROCEDURE. Use slip proof boots while cleaning tank.

(b) Enter tank using safety measures such as tie-downs, safety ladders, and slip proof boots and avoid getting any particles or spray in any body orifices.

(c) Observe suction arm clearance from floor around total tank circumference, level by using turn-buckles as necessary to obtain equal arm clearance from tank floor. Use 1" spacer for measurement.

(d) Observe drag on arms by pulling with a spring scale. (Should not exceed 20 pounds; if it does, refer to corrective maintenance.)
WHY: if clearances and drag are as specified, the collectors should perform with reliability for another year.

(e) Exit tank using same safety measures and proceed with START-UP PROCEDURE for unit.

(f) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Use tie-downs and safety ladders when entering empty tanks.
WHY: to prevent falls and injury.

(c) Use slip proof boot treads while cleaning tanks.
WHY: to prevent slips and falls resulting in injury.

(d) Avoid getting any particles or spray in any body orifices.
WHY: to prevent pathogenic organisms in the sewage from causing infections by entering human orifices.

BAFFLES (Skirt, Submerged)

1. NORMAL PROCEDURE--None

2. POSSIBLE MALFUNCTIONS

   (a) Baffle fastenings fail (pulled loose, rusted), causing baffle to fall to tank floor: observed by operator.
   REF: sedimentation tank manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sweep collector drive motor by turning control to OFF. Divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: sedimentation tank manufacturer's maintenance manual.
   FREQ: annually.
   COND:
   (a) Fastening bolts loose: seen by operator.
   ACT: tighten bolts with wrench.

   (b) Portions of skirt cracked or missing: seen by operator.
   ACT: manually replace cracked or broken skirt panels.

   (c) Grease deposits on skirt: seen by operator.
   ACT: hose down area behind skirt under peripheral influent channel with high pressure hose.
   GEN ACT:
   (a) Drain tank by following SHUT-DOWN PROCEDURE.

   (b) Enter tank using safety measures such as safety ladders, tie-downs, and slip proof boots.

   (c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Use proper ladders and safety equipment.
   WHY: to prevent falls and possible injury.

   (b) Use proper size wrenches when tightening bolts.
   WHY: improper wrenches could slip on bolts and cause injury.

WEIRS (Effluent)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: effluent running evenly over clean weirs.
ACT: operator looks at effluent flowing over weirs, washes down with high pressure hose if any solids build-up is present.

2. POSSIBLE MALFUNCTIONS

(a) Weir not level (effluent flowing unevenly over weirs): seen by operator.
REF: sedimentation tank manufacturer's maintenance manual.
IMM OP ADJ: none.
WHY: if the weir is not level, short circuiting will occur causing localized high velocities and by-passing of the majority of the sedimentary basin resulting in solvents carryover.

3. PREVENTIVE MAINTENANCE
REF: sedimentation tank manufacturer's maintenance manual.
FREQ: annually.
COND:
(a) Any evidence of failure of protective coating: seen by operator.
ACT: sandblast and use wire brush to remove all dirt and original coatings from weirs; reapply protective coating to affective areas.
GEN ACT:
(a) Proceed with SHUT-DOWN PROCEDURE in order to drain the tank.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Follow START-UP PROCEDURE for process.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

MOTOR (Secondary Sludge Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate (can hold hand on motor for 30 seconds--compare with previous temperatures), running with low, even hum, shaft turning, and bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearings for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (c) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (d) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

   (e) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: tighten motor mounts bolts with wrench.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint or black stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

(c) Electrical connections loose or frayed: seen by operator.
ACT: refer to corrective maintenance.
WHY: loose or frayed wires may cause a fire hazard.

GEN ACT:

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

(e) Use grease gun to apply proper amount and type of lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard.

Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

VARIABLE SPEED DRIVE (Secondary Sludge Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: running quietly with no vibration.
   ACT: operator feels and listens to drive component.

2. POSSIBLE MALFUNCTIONS

   (a) Rattling or thumping noises: heard by operator.
       REF: drive manufacturer's maintenance manual.
       IMM OP ADJ: cut power to drive motor by turning control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (b) Motor turning, output shaft of drive not turning: seen by operator.
       REF: drive manufacturer's maintenance manual.
       IMM OP ADJ: cut power to pump motor by turning control switch to OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: drive manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Worn belt (cracked or frayed): seen or heard by operator.
       ACT: notify supervisor and refer to corrective maintenance.
   GEN ACT:
   (a) While drive is running, manually turn selector wheel to highest speed position.

   (b) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
       WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (c) Remove inspection plate by prying off with screwdriver.

   (d) Inspect belt by observation while prodding belt with a screwdriver.

   (e) Manually replace inspection plate.

   (f) Use grease gun to lubricate with correct amount of proper lubricant as designated by drive manufacturer's maintenance manual.

   (g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

Variable Speed Drive (Secondary Sludge Pump)--Continued

(h) While component is running, move speed selector through entire speed range.
WHY: changing speed setting while drive is not running will damage drive.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Replace inspection plate before starting motor.
WHY: to avoid possibility of operator becoming mangled by belt and pulleys.

COUPLING (Secondary Sludge Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: coupling running smoothly and quietly; motor, drive, and pump are in straight line and connecting belts are intact.
   ACT: operator listens for unusual sounds when component is running and looks at coupling bolts and alignment when component is not running; looks for vibrations while running.

2. POSSIBLE MALFUNCTIONS

   (a) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: semi-annually.
   COND: none.
   GEN ACT:
   (a) Manually turn secondary sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Avoid putting hand behind safety screen around coupling when using grease guns to lubricate coupling with proper type and quantity of lubricant as designated by coupling manufacturer's maintenance manual.

   (c) Wipe up all spilled lubricant with rags and/or absorbent.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn secondary sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Avoid putting hand behind safety screen around coupling when using grease gun to lubricate coupling.
WHY: to prevent physical harm to hands done by rapidly rotating parts.

(c) Wipe up all spilled lubricant with rags and/or absorbent.
WHY: to prevent slippery conditions and possible falls.

SECONDARY SLUDGE PUMP (Centrifugal)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: pump turning at speed designated on name plate. Discharge pressure within limits indicated on name plate. Temperature of bearings within range given on name plate. No unusual noises or vibrations.
ACT: operator determines temperature of bearings with fingers and notes vibration level at the same time. He observes packing gland dripping slightly and listens for unusual noise.

2. POSSIBLE MALFUNCTIONS

(a) Excessive leakage of sludge stream at packing gland: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(b) No flow over weir, pump hot to touch (pump air bound, not pumping): seen and felt by operator.
REF: pumped manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

(c) Output of controller on gage does not match flow over weir; unit not pumping correct quantity of flow (called for by controller; measured depth of flow over weir does not agree with graph within ± 10%): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to sludge pump motor by turning control switch to OFF, divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Excessive seal water flow at packing gland: seen by operator.
ACT: tighten gland to reduce flow (1/4 turn each bolt (side); observe and continue turning slowly until leakage is equal to a drip/second or so). If gland will not adjust to prevent leakage, repack pump. Look at sleeve wear while packing is out.

Continued

GEN ACT:

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually close suction and discharge valves.

(c) Drain pump as specified in pump manufacturer's maintenance manual.

(d) Use grease gun to lubricate component with proper type and quantity of lubricant designated in manufacturer's instructions.

(e) Manually pull inspection plate (open pump case) to verify by observation that the impeller is not damaged (chipped, cracked, or clogged up). If damaged, refer to corrective maintenance.

(f) Manually replace inspection plate and open suction and discharge valves.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent flooding of immediate area which could cause injury to operator.

SKIMMING DEVICE (Telescopic Valve)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: the telescopic valve is positioned so that the inlet rim is slightly above the liquid surface level of the peripheral inlet channel.
ACT: operator looks at the telescopic valve and notes that the valve is raised so that the inlet rim is above the surface level of the channel. The operator manually adjusts the position of the telescopic valve if necessary.
WHY:
(a) When the telescopic valve has flow going into it, an unmeasured amount of solids will be lost from the secondary process.

(b) The flow into the telescopic valve is additional flow that has to be repumped by the plant lift pumps.

2. POSSIBLE MALFUNCTIONS

(a) Telescopic valve moves up and down as hand wheel turns with much difficulty: seen and felt by operator.
REF: plant lubrication manual, valve manufacturer's maintenance manual.
IMM OP ADJ: none.

(b) Telescopis valve does not go up and down as hand wheel turns freely: seen and felt by operator.
REF: plant lubrication manual, valve manufacturer's maintenance manual.
IMM OP ADJ: observe the position of the telescopis valve. Notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: valve manufacturer's maintenance manual and plant lubrication manual.
FREQ: monthly.
COND:
(a) Set screws loose or missing: seen by operator.
ACT: tighten or replace set screws with allen wrench.
WHY: loose set screws will cause pins to fall out or shear off.

(b) Stem is rusty or caked with dried grease: seen by operator.
ACT: clean with rag and oil valve stem with oil designated in plant lubrication manual. Manually run valve through complete range up and down.
WHY: a rusty stem or caked stem will become hard to turn and may cause a pin to slip or shear off.

Continued

Skimming Device (Telescopic Valve)--Continued

GEN ACT:

(a) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Use both hands to turn the valve wheel. Do not spin the valve wheel.
WHY: spinning the valve wheel may cause the spokes to hit and injure the fingers when trying to stop the wheel.

SURFACE SKIMMING SPRAYS

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: sprays are all spraying a 3-foot diameter size, fan-shaped pattern and moving the scum along the water surface; spray impinges on the water surface at an angle of about 30° from the horizontal.
ACT: operator looks at the sprays and notes the above characteristics. Operator manually adjusts the spray heads as necessary.
WHY:

(a) A spray head that is plugged will allow scum to accumulate in its coverage area.

(b) Excessive spray velocity will cause the scum particles to be rolled under the water surface instead of moving them horizontally along the surface.

(c) The spray hitting the water surface at too steep an angle will cause the scum particles to be driven below the water surface.

2. POSSIBLE MALFUNCTIONS

(a) Water not coming from any of the spray heads: seen by operator.
REF: plant operation manual.
IMM OP ADJ: manually open spray head manifold valve.

(b) Some spray heads are partially or totally plugged: seen by operator.
REF: plant operations manual.
IMM OP ADJ: none.

3. PREVENTIVE MAINTENANCE
REF: plant operation manual.
FREQ: monthly.
COND: none.
GEN ACT:

(a) Manually open flushing valves at the spray manifold ends.
WHY: to flush out particles that might plug the sprays.

(b) Manually close flushing valves and spray head manifold valve.

(c) Replace missing or damaged spray heads by using wrench.

(d) Turn manifold pipes with wrench so sprays hit the water at the proper angle (30°).

(e) Manually open spray head manifold valve to determine angle the sprays are hitting the water. Avoid spray water entrance into body openings.

(f) If not at proper angle, manually close spray head manifold valve and adjust with wrench to correct angle. (If at approximately 30° angle, continue the spraying process.) Use both hands to turn the valve wheel.

Continued

4. MAJOR SAFETY FACTORS

(a) Prevent spray water from getting into the eyes or body openings when cleaning plugged sprays with wire.
WHY: spray water still contains organisms even after it has been chlorinated--can cause infections.

(b) Use both hands to turn the valve wheel. Do not spin the valve wheel.
WHY: spinning the valve wheel may cause the spokes to hit and injure the fingers when trying to stop the wheel.

INLET GATE

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: gate kept in storage slot adjacent to tank or in use, flow unobstructed.
   ACT: operator sees gate is in proper slot as designated by daily log book.

2. POSSIBLE MALFUNCTIONS--None

3. PREVENTIVE MAINTENANCE
   REF: sedimentation tank manufacturer's manual.
   FREQ: annually.
   COND:
   (a) Edges of gate damaged (torn or burred): seen by operator.
   ACT: lightly file edges smooth with file to remove burrs.

   (b) Gate slots filled with sediment: seen by operator.
   ACT: jet material from slots with water from high pressure hose.

   (c) Gate slots damaged (bent or burred): seen by operator.
   ACT: use file to file burrs from gate guides.

   GEN ACT:
   (a) Follow SHUT-DOWN PROCEDURE for gates above and below gate being inspected in the channel in order to drain channel on both sides of gate for inspection.

   (b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary. (Prevent water from squirting back on operator.)

   (c) Use grease gun to lubricate gears with proper lubricant as indicated in reference manual. Clean up spills with absorbent.
   WHY: too much, too little, or the wrong type of lubricant may cause damage to gears.

   (d) Follow START-UP PROCEDURE FOR PROCESS.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Prevent water from squirting back on the operator when water is jetting out of the gate slots.
   WHY: to prevent infection that the pathogenic organisms in the water could cause if allowed into human orifices.

   (b) Clean up all spilled lubricant with rags and/or absorbent.
   WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

DRAIN VALVE

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: drain valve is fully closed; valve cam firmly against the stop.
   ACT: operator observes drain valve is fully closed by looking at the valve position indicating arrow. Notes position of valve cam.
   WHY: a drain valve that is partially open will allow an unmeasured amount of solids to be lost from the secondary process.

2. POSSIBLE MALFUNCTIONS

   (a) Valve turns hard: felt by operator as he attempts to turn it.
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.
   WHY: a valve that is hard to turn may seize tight and cannot be turned at all when it is needed.

   (b) Valves turns easily but won't close completely: seen and felt by operator.
   REF: valve manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: plant operations manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:
   (a) Manually turn the valve open and closed again. Use grease gun, proper amount and type of grease designated in plant operations manual to grease stem of valve if it is hard to turn. (Use proper valve handle.)
   WHY: to verify that the valve will turn freely.

   (b) Verify by observation that valve handles are in their holders when not in use.

4. MAJOR SAFETY FACTORS

   (a) Use the proper valve handle that fits the drain valve stem.
   WHY: a pipe wrench or other make-shift tool might slip and injure the operator or damage the valve stem and render it unusuable.

   (b) Store the valve handles in their holders when not in use.
   WHY:
   (1) A handle might fall on somebody if it is left hanging on a valve.
   (2) Somebody might trip over a valve handle left lying on the floor.

SECONDARY SLUDGE WEIR

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: sludge is flowing smoothly and uniformly over the weir. Amount of sludge flowing over the weir is as called for by the controller; the sludge is normal in appearance and thickness as determined by previous experience.
ACT: operator observes the above conditions.
WHY:
(a) The proper amount of sludge (as determined by lab results) must be removed from the secondary sedimentation tanks.
    (1) Too much sludge removal will cause unnecessary pumping and upset the process.
    (2) Too little sludge removal will cause a high sludge level in the tank and cause process upset.
    (3) Too little sludge removal might cause septic conditions in the secondary sedimentation tank and consequent loss of efficiency.

2. POSSIBLE MALFUNCTIONS

(a) Sludge level is higher than indicated by controller setting: seen by operator.
REF: plant operation manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Little or no sludge is going over the weir: seen by operator.
REF: plant operation manual.
IMM OP ADJ: notify supervisor.
WHY: sludge must be removed from tank to prevent process upset.

(c) Weir is not horizontal (indicated by use of a level): seen by operator.
REF: plant operation manual.
IMM OP ADJ: notify supervisor.
WHY: a weir that is not level will give a false reading as to the flow over the weir.

3. PREVENTIVE MAINTENANCE
REF: weir manufacturer's flow/depth curves.
FREQ: monthly.
COND: none.
GEN ACT:
(a) Verify that actual sludge flow corresponds to flow reading from indicator as follows:
    (1) Measure with stick the depth of flow over weir at several representative pumping rates.
    (2) Determine flow amount from weir curve.
    (3) Compare curve flow amounts with plant sludge flow indicator.

Continued

(b) Notify supervisor if indicator and chart are not in agreement within predetermined limits. If in agreement, proceed with process.

4. MAJOR SAFETY FACTORS

(a) Lock out the sludge pump motor electrical supply breaker before working on the weir.
WHY: to prevent sudden start-up and sludge pumped onto operator allowing pathogenic organisms to enter human orifices.

SLUDGE DEPTH SAMPLERS

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: air lift bringing sample to trough for inspection.
   ACT: operator inspects flow to determine sludge depth.

2. POSSIBLE MALFUNCTIONS

   (a) Air lift fails to lift sample and agitation occurs in tank when valve is opened: observed by operator.
   REF: air lift manufacturer's maintenance manual.
   IMM OP ADJ: manually turn valve off (clockwise), notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: air lift manufacturer's maintenance manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Divert flow to alternate unit by rearranging isolation gates with overhead crane according to plant developed operational manual.

   (c) Drain sludge tank by use of drain valve and continue to hose the tank walls, piping, and tank bottom until all of the sludge is removed.

   (d) Manually shut off and bleed air lines before working on them.

   (e) Enter tank with caution by using safety ladder, harness, and safety boots.

   (f) Inspect visually and by hand the sample piping for damage or deterioration--replace or repair cracked, broken, bent, or rusted pipes with reference to manufacturer's maintenance manual.

   (g) Exit tank with caution as stated above.

   (h) Manually open up and bleed off air lines.

   (i) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn sludge pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Shut off and bleed air lines before working on them.
WHY: when pipe joints are opened, escaping compressed air might blow foreign material into the eyes or other body openings.

(c) Use safety devices such as ladder, harness, and safety boots when entering, exiting, or working in tank.
WHY: to prevent fall or slipping that could break limbs of operator or cause his death.

FIRST AID KIT

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed in inventory sheet in kit.
   ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies and notes location of kit.
   WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

   (a) Kit is missing: seen by operator.
   REF: none.
   IMM OP ADJ: notify supervisor and replace kit with new kit.

   (b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
   REF: first aid kit manual.
   IMM OP ADJ: notify supervisor and replace or repair kit.

3. PREVENTIVE MAINTENANCE
   REF: first aid kit manual or supply list.
   FREQ: at least once every week.
   COND:
   (a) Some supplies missing: seen by operator.
   ACT: determine actual amount of supplies missing.
   GEN ACT:
   (a) Replenish first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.

   (b) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE
   FREQ: at least once every 8 hours.
   COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshall.
   ACT: operator looks at inspection tag of fire fighting equipment. If inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
   WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

   (a) Equipment missing: seen by operator.
   REF: none.
   IMM OP ADJ: notify supervisor.

   (b) Equipment damaged: seen by operator.
   REF: fire fighting equipment maintenance manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: fire fighting maintenance manual.
   FREQ: annually.
   COND:
   (a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
   ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
   GEN ACT:
   (a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
   WHY: low weight indicates extinguisher should be recharged.

   (b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is not low.

   (c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

FIRST STAGE DIGESTION

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
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U. S. Environmental Protection Agency
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FIRST STAGE DIGESTION

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START-UP PROCEDURE FOR PROCESS

1. Inspect the inside of the digester as follows:
   (a) Verify by observation that the inside of the digester is free of tools, ladders, or any extraneous debris. (Do not enter digester until forced air ventilation has been provided, and oxygen deficiency tests and explosive atmosphere tests have been run.)

   (b) Verify by observation that all internal piping joints are tight, piping is in place and securely fastened at the support points, and that all bolts are tight.

   (c) Look into or run air or water through all piping to verify that all lines are open.
   WHY: once the digester is full of liquid, the inside piping will be inaccessible.

   (d) Verify by observation that all personnel are clear of the unit and are aware of the start-up.
   WHY: to prevent injury to personnel.

2. Inspect the outside of the digester as follows:
   (a) Verify by observation that all piping joints are tight, piping is in place and securely fastened at the support points, and that all bolts are tight.

   (b) Run air or water through all piping to verify that all lines are open.

   (c) Manually turn all valves to make sure that they turn freely.
   WHY: if there are valve or piping malfunctions once the digester is full of liuqid, it would be necessary to drain the digester to do repair work.

3. Inspect all components of the digester external equipment for power available, piping clean and solidly anchored, valves properly positioned, couplings tight and aligned, pumps packed and water flow to packing. Inspect by observation all external power switches to assure that all motors are tagged and physically padlocked. Manually turn motor control switch to OFF, padlock electrical power supply switches in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component. External components are raw sludge pump, coupling and motor, hot water recirculation pump, coupling and motor, sludge recirculation pump, motor and coupling, compressor and drive, gas meter, gas manometer, water traps, regulators, pressure and vacuum relief valves, flame arresters, sludge flow meters and density meter.
   WHY: once the digester is in operation, a malfunction of certain pieces of external equipment will impede or stop the digester operation.

Continued

4. Fill the digester with raw sewage to the normal operating level as determined by the supernatant overflow.

   (a) Manually open the raw sewage inlet valve to the raw sludge pump suction.

   (b) Manually open the discharge valve from the raw sludge pump to the digester.

   (c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn raw sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (d) Manually stop the raw sludge pump by turning the control switch to OFF when the raw sewage begins to flow out the supernatant line.

   (e) Visually inspect for liquid leaks. If leaks are found, refer to corrective maintenance.

   (f) Use raw sewage instead of raw sludge to fill the digester.
   WHY:
   (1) Raw sludge will cause the digester to immediately go into an overloaded state.
   (2) Raw sewage is easier to handle in case the digester had to be drained right away for repair work.

5. Seal all digester openings (by closing valves, covering hatches with bolted covers, etc.) including gas lines, pressure relief vent, inspection manholes, supernatant lines, raw sludge feed lines, digested sludge draw-off lines, and sludge recirculating lines.

6. Using a water column pressure indicator, slowly pressurize the digester gas dome to 15-18 inches (check design data) of water column using compressed air as follows:

   (a) Paint joints and gasket seals with a soapy solution and look for soap bubbles to determine whether there are leaks. If there are leaks, refer to corrective maintenance.

   (b) Verify by observation that the digester maintains a minimum time static pressure loss as specified by the design data. If it does, refer to corrective maintenance.

   (c) Use water column pressure indicator to verify that the digester gas pressure relief vent will open at 15 inches (verify by design data) of water column.
   WHY: digester gas leaks could cause explosion/fire hazard.

7. Unseal all digester openings necessary for normal operation including the raw sludge lines, pressure relief vent, gas lines, supernatant lines, and sludge recirculation lines. Reconnect any lines that had been disconnected during the sealing process when hunting for gas leaks.

8. Fill the gas manometer with water to the "zero" level marks.

Continued

Start-Up Procedure--Continued

9. Manually open the inlet and outlet valves to the digester recirculating sludge pump.

10. Remove red LOCK-OUT-TAG, unlock electrical power supply switches of exchange hot water recirculating pump, digester recirculating sludge pump, and heat exchanger burner control.

11. Manually turn on the heat exchanger hot water recirculation pump and the digester recirculating sludge pump by turning the respective motor switches to ON.

12. Manually turn on the heat exchanger burner control by turning the control switch to ON. Verify by observation that the digester gas valve is closed and the auxiliary fuel valve is open.
    WHY: there won't be enough digester gas available from the secondary digester to burn in the heat exchanger.

13. Continue to heat the digester raw sewage until the recirculating sludge inlet temperature is 90°F. (Check PROCESS CONTROL INSTRUCTIONS for exact temperature.)

14. Start adding raw sludge to the digester at the appropriate rate of 0.4% of the digester liquid contents per day.

15. Maintain the digester recirculating sludge pH within the 6.8--7.2 range by adding powdered lime as follows:

    (a) Mix the lime with water before adding it to the digester. A sump pump in a barrel discharging back into the barrel makes a suitable mixing device.

    (b) The amount of lime needed is directly proportional to the amount of raw sludge added per day.

16. Add seed sludge to the digester in the amount of 5-10% of the digester capacity if seed sludge is available either from the secondary digester or hauled in by truck from a nearby digester.

17. Follow process control instructions while bringing the digester into operation.

18. Light the waste gas burner as soon as the digester gas is of burnable quality.

19. When the digester gas production is of sufficient quantity (determined with reference to manufacturer's specifications on design) and quality (40% CO_2) to burn in the heat exchanger, switch from auxiliary fuel to digester gas fuel as follows:

    (a) Purge gas line to heat exchanger burner by venting out the burner stack before trying to ignite the burner.

Continued

MAJOR SAFETY FACTORS

(a) Do not enter digester until forced air ventilation has been provided and oxygen deficiency tests and explosive atmosphere tests have been run.
WHY: explosive, toxic, poisonous, and suffocating gases are present in all digesters and can cause sickness or death to operator.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Allow no smoking or open flames in digester area.
2. Manually shut off power to gas mixer drive motor by turning control switch to OFF. Place red LOCK-OUT-TAG on power box for switch before performing any work on the component. This should be done at least 24 hours before digester draining procedures begin.
3. Change raw sludge feed to secondary digester by opening secondary digester feed valve and then closing primary digester feed valve.
4. Withdraw all digested sludge to digested sludge handling unit (drying beds, vacuum filter, centrifuge) by opening bottom draw-off valve from primary digester and routing sludge through appropriate valving to component.
5. Using a digester circulating pump, transfer primary digester solids to the secondary digester by lining up valving from a low primary (not bottom) circulating valve to the secondary digester.
6. When the level of sludge is below the side wall access point, remove side access covers by unbolting to provide ventilation and better inspection of the bottom materials. Allow no smoking or open flames within 30 feet of the open port.
7. If a sand build-up in the bottom of the digester is evident, transfer only as much sludge to the secondary digester as possible without also transferring sand.
8. From the side wall access port, hose down with fire hose all interior surfaces, piping, etc. Do not enter the digester until provision has been made for high volume, forced air ventilation.
9. When personnel are ready to enter the digester, provide, in addition to ventilation, safety harnesses and lines tended by a man watching from the access port. If a ladder is used, tie a line to its top rung and secure the line firmly outside the digester. If an extension ladder is used, extend ladder to length needed and tie overlapping rung areas securely to prevent loss of lower section in digester. Allow no sludge to splash in eyes, ears, nose, or mouth.
10. Make provisions for removal and disposal of sand and proceed until digester is empty. (This project can be undertaken by plant personnel or contracted to outside companies. Sand can be disposed of by burial, landfill, etc.)
11. Finish hose down of digester interior. Pull off all hanging strings of rags from pipings, pipe hangers, and brackets.

Continued

Shut-Down Procedure--Continued

12. Visually inspect all interior piping, hangers, supports, and footings for signs of failure or deterioration. Record all findings for reference at future inspections. Repair or replace any equipment showing indications of advanced deterioration. (Use caution when dismantling digester piping.)

13. Manually turn motor control switches to OFF at appropriate times designated by supervisor, padlock electrical power supply switches in OFF position, and place red LOCK-OUT-TAG on power boxes.

MAJOR SAFETY FACTORS

(a) Allow no smoking or open flames in digester area.
WHY: digester gases are flammable and/or explosive when ignited causing injury or death to operator.

(b) Allow no sludge to splash in eyes, ears, nose or mouth. Flush areas with fresh water if sludge is accidentally splashed on body.
WHY: high bacterial content of sludge may cause disease which could result in illness or death of operator.

(c) Use caution when dismantling digester piping.
WHY: iron sulfide oxidizes rapidly on contact with atmospheric oxygen causing possible heat or flame which could injure or kill operator.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

1.	Motor (Raw Sludge Pump Drive)	every 4 hours
2.	Variable Speed Drive (Raw Sludge Pump)	" " "
3.	Raw Sludge Pump (Piston Type, Belt Driven)	" " "
4.	Heat Exchanger	" " "
5.	Motor (Hot Water Recirculation)	" " "
6.	Coupling (Hot Water Recirculation)	" " "
7.	Pump (Centrifugal, Hot Water Recirculation)	" " "
8.	Motor (Sludge Recirculation)	" " "
9.	Coupling (Sludge Recirculation)	" " "
10.	Pump (Centrifugal, Sludge Recirculation)	" " "
11.	Motor (Gas Recirculation Compressor)	" " "
12.	Coupling (Gas Recirculation)	" " "
13.	Compressor (Gas Recirculation)	" " "
14.	Gas Manometers	" " "
15.	Raw Sludge Flow Meter (Magnetic)	" " "
16.	Raw Sludge Density Meter (Nuclear)	" " "
17.	Piping and Valves	every 8 hours
18.	Gas Meter (Production)	" " "
19.	Gas Water Traps (Condensate)	" " "
20.	Gas Regulators (Pressure)	" " "
21.	Gas Pressure and Vacuum Relief Valves (Digester Cover)	" " "
22.	Flame Arrestors (Gas Piping)	" " "
23.	First Aid Kit	" " "
24.	Fire Fighting Equipment	" " "
25.	Digester Internal Piping (Gas Mixing)	" " "
26.	Gas Meter (Production)	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

1.	Variable Speed Drive (Raw Sludge Pump)	weekly
2.	Pump (Centrifugal, Hot Water Recirculation)	weekly/semi-annually
3.	First Aid Kit	weekly
4.	Pump (Centrifugal, Sludge Recirculation)	weekly/semi-annually
5.	Motor (Raw Sludge Pump Drive)	monthly
6.	Raw Sludge Pump (Piston Type, Belt Driven)	monthly/annually
7.	Piping and Valves	monthly/semi-annually
8.	Motor (Hot Water Recirculation Pump)	monthly
9.	Motor (Sludge Recirculation Pump)	"
10.	Motor (Gas Recirculation Compressor)	"
11.	Gas Manometers	"
12.	Raw Sludge Flow Meter (Magnetic)	monthly/annually
13.	Raw Sludge Density Meter (Nuclear)	monthly
14.	Coupling (Hot Water Recirculation)	quarterly
15.	Coupling (Sludge Recirculation)	"
16.	Coupling (Gas Recirculation)	"
17.	Compressor (Gas Recirculation)	semi-annually
18.	Gas Water Traps (Condensate)	"
19.	Flame Arrestors (Gas Piping)	"
20.	Digester Internal Piping (Gas Mixing)	"
21.	Heat Exchanger	annually
22.	Gas Meter (Production)	"
23.	Gas Regulators (Pressure)	"
24.	Gas Pressure & Vacuum Relief Valves (Digester Cover)	" "
25.	Fire Fighting Equipment	"

ABNORMALS AND RELATED SAFETY FACTORS FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Supernatant

   (a) Foaming: seen by operator.
   CAUSE:
   (1) Scum blanket breaking up.
   (2) Excessive gas recirculation.

   (b) Lumps and particles of scum: seen by operator.
   CAUSE:
   (1) Scum blanket breaking up.
   (2) Excessive mixing.
   (3) Scum blanket too thick.

   (c) Gray or brown color (different than normal black color): seen by operator.
   CAUSE:
   (1) Inadequate stratification of digester contents.
   (2) Digestion time too short.
   (3) Digester ecological balance upset.
   (4) Overloaded digester.

   (d) Sour odor: smelled by operator.
   CAUSE:
   (1) pH of digester contents too low.
   (2) Second stage of digestion retarded.
   (3) Overloaded digester.

2. Digester Gas

   (a) Yellow flame from waste gas burner: seen by operator.
   CAUSE: poor quality gas--excessive percentage of CO_2.

   (b) Lower than usual waste gas flame: seen by operator.
   CAUSE:
   (1) High gas usage in plant.
   (2) Low gas production.
   (3) Gas leak from digester piping.

   (c) Waste gas burner not lit: seen by operator.
   CAUSE: pilot flame not burning.

Continued

Abnormals and Probable Causes for Process--Continued

3. Digested Sludge

   (a) Gray or brown color (different than normal black color): seen by operator.
   CAUSE:
   (1) Improper digestion.
   (2) Excessive digester mixing.

   (b) Sour odor (different from normal tar odor): smelled by operator.
   CAUSE:
   (1) pH of digester contents too low.
   (2) Second stage of digestion retarded.
   (3) Overloaded digester.

4. Digester Scum Blanket (as viewed from sight glass in digester cover): seen by operator.

   (a) Rolling movement slight or absent: seen by operator.
   CAUSE:
   (1) Gas mixer is off.
   (2) Inadequate mixing time.
   (3) Scum blanket too thick.

   (b) Dry and cracked scum blanket (different from normal dark, muddy texture): seen by operator.
   CAUSE:
   (1) Inadequate mixing.
   (2) Scum blanket too thick.

   (c) Scum level too low: seen by operator.
   CAUSE:
   (1) Supernatant level valve set too low.
   (2) Digested sludge line open to drain.
   (3) Recirculating line open to drain.

   (d) Scum blanket too high: seen by operator.
   CAUSE:
   (1) Supernatant overflow plugged.
   (2) Scum blanket too thick and is being pushed up by other scum below like a cork.

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Grab--raw sludge

   FREQ: at least once a day.
   ACT: use clean sampling apparatus of at least one liter capacity. Collect at point closest to entry into digester. Deliver immediately to laboratory. Collect sample at midpoint of pumping cycle.

2. Grab--recirculated sludge

   FREQ: at least once a day
   ACT: use clean sampling apparatus of at least one liter capacity. Collect at discharge from digester before entry to heat exchanger. Deliver immediately to laboratory. Let stream run at least one liter before taking sample.
   WHY: to avoid getting dried old sludge from spigot.

3. Grab--supernate

   FREQ: at least once a day.
   ACT: use a clean sampling apparatus of at least one liter capacity. Collect at discharge from digester at midpoint of pumping cycle. Deliver immediately to laboratory.

4. Grab--digester gas

   FREQ: at least once a day.
   ACT: attach intake of gas analyzer to spigot. Perform analysis as designated by laboratory analysis section. Close spigot and remove analyzer.

5. Grab--profile sampling

   FREQ: at least once every 6 months.
   ACT: lower sampler through thief hole to various depths at intervals of four feet. Deliver samples to laboratory immediately. At same time measure and record the depth of the scum blanket.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTOR (Raw Sludge Pump Drive)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate; running with low even humming sound, shaft turning, and bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to ON (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switch gear. If, when reset, motor won't run manually, turn power to motor OFF at control switch. Start alternate unit. Notify supervisor and refer to corrective maintenance before proceeding.

   (b) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's manual.
   IMM OP ADJ: manually turn power to motor OFF at control switch. Start alternate pump. Notify supervisor and refer to corrective maintenance.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's manual.
   IMM OP ADJ: manually turn power to motor OFF at control switch. Start alternate pump. Notify supervisor and refer to corrective maintenance before proceeding.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (f) Smoke rising out of casing: seen and/or smelled by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

Continued

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint around motor base: seen by operator.
ACT: manually tighten motor mounts bolts with wrench.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint and smoke and/or smoke stains: seen by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

Continued

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

VARIABLE SPEED DRIVE (Raw Sludge Pump)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: running quietly with no vibrations.
ACT: operator feels and listens to drive component.

2. POSSIBLE MALFUNCTIONS

(a) Rattling or thumping noises: heard by operator.
REF: drive manufacturer's maintenance manual.
IMM OP ADJ: cut power to drive motor by turning control switch to OFF and start alternate pump. Refer to corrective maintenance.

(b) Motor turning, output shaft of drive not turning: seen by operator.
REF: drive manufacturer's maintenance manual.
IMM OP ADJ: cut power to pump motor by turning control switch to OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: drive manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Worn belt (cracked or frayed): seen or heard by operator.
ACT: notify supervisor and refer to corrective maintenance.
GEN ACT:
(a) While drive is running, manually turn selector wheel to highest speed position.

(b) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(c) Remove inspection plate by prying off with screwdriver.

(d) Inspect belt and pulleys by observation while prodding belt with a screwdriver.

(e) Manually replace inspection plate.

(f) Use grease gun to lubricate with correct amount of proper lubricant as designated by drive manufacturer's maintenance manual.

(g) Clean up spilled lubricant with rags and/or absorbent.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

Continued

Variable Speed Drive (Raw Sludge Pump)

(i) While component is running, move speed selector through entire speed range.
WHY: changing speed setting while drive is not running will damage drive.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause injury or death to operator.

(b) Replace inspection plate before starting motor.
WHY: to avoid possibility of operator being mangled by belt and pulleys.

(c) Use screwdriver while inspecting belts.
WHY: to prevent mangling of fingers in case of accidental start-up.

(d) Clean up spilled lubricant with rags and/or absorbent.
WHY: spilled lubricant could cause slippery surface which may cause operator to slip and injure back, head, or other parts of body.

RAW SLUDGE PUMP (Piston Type, Belt Driven)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: oiler on eccentric strap dripping at normal rate (varies with different equipment). Water supply to packing flowing enough to lubricate piston without excessive waste of water. (A permanent reservoir of heavy oil is sometimes used instead of water.) Drive belt tension approximately one inch slack with pump off, normal pumping rate shown on (a) flow meter, (b) pump discharge pressure, (c) pump motor ammeter, or combination of these. No unusual noises or vibrations.
   ACT: operator visually observes oiler, piston water supply, supernatant flow, and digester gas pressure manometer.
   WHY: a plugged supernatant overflow, observed, or indicated by rapidly rising digester gas pressure could lead to structural damage to the digester due to over pressure.

2. POSSIBLE MALFUNCTIONS

   (a) Sludge leaking around piston: seen by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (b) Lower than normal discharge pressure: seen by operator on discharge pressure gage.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (c) Packing too tight (no drip from gland seal and/or no flow through rotometer): seen by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (d) Eccentric strap heats up: smelled or felt by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (e) Loose drive belts: seen or heard by operator.
   REF: pump manufacturer's maintenance manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

   (f) Suction line plugged (visual observation of suction pressure gage shows drastic change): seen by operator.
   REF: plant operations manual.
   IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

Continued

(g) Pump running but no sludge is being discharged and/or discharge pressure gage shows no pressure: sludge seen and gage read by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(h) Pump leaking (excessive amount of water around gland): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(i) Pump pulley turning but piston not working: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(j) Motor running but pump pulley not turning: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(k) Pump knocking or making unusual noise: heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(l) Motor not running: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
FREQ: weekly.
COND:
(a) Frayed, slack or cracked belt: seen by operator as he presses on belt.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

Continued

(c) Check oil in gear box for proper amount by looking at sight gage or dipstick; add oil of necessary.

(d) Clean up any spilled oil with rags and/or absorbent.

(e) Use screwdriver to tighten screws in pulleys.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Remove drain plug with wrench and completely drain old oil.

(c) Replace drain plug with wrench and fill to correct level with proper oil as designated by the manufacturer's maintenance manual.

(d) Remove gear box cover, check for worn teeth (teeth not meshing at least one quarter of an inch), and broken teeth. Determine, by trying to move with hand, if gears are loose on shaft (if loose, tighten will allen wrench).

(e) Replace gear box cover.

(f) Fill gear box to the correct level with the proper oil designated in the manufacturer's maintenance manual.

(g) Clean up any spilled oil with rags and/or absorbent

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

FREQ: annually.
COND:
(a) Plunger piston worn or scored: seen by operator.
ACT: repair or replace piston as necessary.
GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Remove ball checks, accurately determine wear from previous experience; replace if necessary.

(d) Inspect by observation the ball seats for cracks or broken places. Repair if necessary.

(e) Inspect by observation upper bearing and eccentric strap clearances. Restore to manufacturer's specifications if necessary.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Manually close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent accidental splashing of sludge on operator causing infection to open cuts.

VALVES

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: valves that should be open are open; valves that should be closed are closed (valve positions to be obtained from supervisor).
   ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

   (a) Handle frozen: operator tries to move handle.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

   (b) Broken stem: seen by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

   (c) Leaking around stem: seen by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

   (d) Valve turns hard: felt by operator as he attempts to turn it.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

   (e) Valve turns easily but won't close completely: seen and felt by operator.
   REF: valve manufacturer's instruction manual.
   IMM OP ADJ: refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's maintenance manual.
   FREQ: monthly.
   COND: none.
   GEN ACT:
   (a) Wipe old grease from valve stem with rags.

   (b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.

   (c) Move valve through one complete cycle (completely open then completely closed). If it does not completely open(close), refer to corrective maintenance.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

PIPING

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: no visible leaks.
   ACT: operator looks at all pipe and fittings that are visible.

2. POSSIBLE MALFUNCTIONS

   (a) Minor leak (dripping of water): seen by operator.
   REF: plant developed maintenance manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (b) Major leak (steady stream, gushing of water): seen by operator.
   REF: plant developed operation manual.
   IMM OP ADJ: alter valve arrangement to bypass leak and immediately notify supervisor. Manually close valves to isolate leak and start alternate units.

3. PREVENTIVE MAINTENANCE
   REF: plant developed maintenance manual.
   FREQ: annually.
   COND:
   (a) Minor leaks (dripping) of water: seen by operator.
   ACT: repair by tightening joints that leak. Patch leaks along joint of pipe with material specified in plant developed maintenance manual.

   (b) Cracks in expansion joints: seen by operator.
   ACT: for replacement, refer to corrective maintenance.
   GEN ACT:
   (a) Look for conditions above and take appropriate actions.

   (b) Remove cracked and peeling paint and rust with wire brush.

   (c) Repaint with proper kind and color of paint as designated in plant developed maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

HEAT EXCHANGER

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: sludge is being recirculated through the heat exchanger, the gas flame is burning, the exhaust fan is running, and the hot water recirculation pump is pumping.
ACT: the operator observes that the sludge outlet temperature is slightly higher than the sludge inlet temperature, the hot water temperature is within normal (130-140°F) limits, the gas flame is of normal bluish appearance, there are no unusual noises, and there are no liquid or gas leaks. (Temperatures read from mounted thermometers.)
WHY:

(a) The recirculating sludge must have a temperature increase as it goes through the heat exchanger in order to maintain a constant digester temperature.

(b) A hot water temperature that is too hot (over 130°F) will cause recirculating sludge to cake on the heat exchanger coils and reduce heat transfer efficiency.

(c) A hot water temperature that is too cool will not heat the recirculating sludge enough to maintain the desired digester temperature.

(d) A gas flame that has a yellowish color indicates poor quality gas or improper air ratio mixture.

2. POSSIBLE MALFUNCTIONS

(a) Digester recirculating sludge inlet temperature to the heat exchanger is increasing or decreasing: seen by operator on temperature recorder chart.
REF: heat exchanger manufacturer's maintenance manual.
IMM OP ADJ: adjust the recirculating sludge temperature control to compensate for the changing temperature. Refer to corrective maintenance.

(b) Gas flame will not ignite: seen by operator.
REF: heat exchanger manufacturer's maintenance manual.
IMM OP ADJ: light the pilot flame and reset the burner control. If the gas flame still does not ignite, turn the burner control to OFF and notify supervisor. Refer to corrective maintenance.

(c) Gas flame is burning with a yellowish color: seen by operator.
REF: heat exchanger manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

(d) Hot water temperature read on thermometer is above or below determined limits (approximately 96°F): seen by operator.
REF: plant operation manual.
IMM OP ADJ: turn recirculating sludge pump and burner control to OFF. Notify supervisor.

Continued

3. PREVENTIVE MAINTENANCE
   REF: heat exchanger manufacturer's maintenance manual.
   FREQ: annually.
   COND: none.
   GEN ACT:

(a) Manually turn burner control, hot water recirculation pump, and sludge recirculation pump switches to OFF.

(b) Manually shut off all sludge and gas supply valves.

(c) Place LOCK-OUT-TAG on main power breaker to heat exchanger component.

(d) Verify by observation that all flame safety or regulating devices are in use and not bypassed or overlooked.

(e) Verify by smell that digester gas does not contain small amounts of hydrogen sulfide or that gas is too concentrated to work in. If so, notify supervisor immediately.

(f) Drain sludge, hot water, and vent gas lines in exchanger component by removing plug.

(g) Dismantle exchanger component by removing bolts with wrench and clean tubes with tube brush and piping inside and out.

(h) Repair firebox and flue as needed.

(i) Reassemble component by replacing bolts on exchanger and replacing plug.

(j) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(k) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Verify by observation that all flame safety or regulating devices are in use and not bypassed or overlooked.
WHY: digester gas is explosive and can cause injury or death to operator.

Continued

Heat Exchanger--Continued

(b) Verify by smell that digester gas does not contain small amounts of hydrogen sulfide or that gas is too concentrated to work in.
WHY:

  (1) Digester gas could be poisonous if it contains even very small amounts of hydrogen sulfide causing sickness or death of operator.

  (2) Digester gas can cause death of operator due to asphyxiation if gas is in concentrated amounts.

MOTOR (Hot Water Recirculation Pump)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate; free of vibration; running with normal low, even humming sound; shaft turning; and bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen and/or heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switchgear.
   If, when reset, motor won't run manually, turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

   (b) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Notify supervisor and refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

Continued

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust, thereby producing a fire hazard.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury to operator.

COUPLING (Hot Water Recirculation)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: coupling running smoothly and quietly; motor, drive, and pump are in straight line and connecting bolts are intact.
   ACT: operator listens for unusual sounds (whining or screaming) when component is running and looks at coupling bolts and alignment when component is not running; looks for vibrations while running.

2. POSSIBLE MALFUNCTIONS

   (a) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: turn motor control switch to OFF and start alternate pump. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: quarterly.
   COND: none.
   GEN ACT:
   (a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Use grease gun to lubricate coupling with proper type and quantity of lubricant as called for in manufacturer's maintenance manual.

   (c) Wipe up all spilled lubricant with rags and/or absorbent.

   (d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (e) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

   (b) Wipe up all spilled lubricant with rags and/or absorbent.
   WHY: to prevent slippery conditions and possible falls.

PUMP (Centrifugal, Hot Water Recirculation)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: pump turning at normal speed (not slowing up, then getting faster). Discharge pressure within limits indicated on name plate. Temperature of bearings within proper range (can hold hand on bearing housing for at least 30 seconds). No unusual noises or vibrations.
ACT: operator feels bearing housing and observes vibrations at the same time. He observes packing gland dripping slightly and listens for unusual noises.

2. POSSIBLE MALFUNCTIONS

(a) Excessive leakage of sludge at packing gland: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: adjust packing gland by tightening nuts equally to reduce flow to proper level. If gland will not adjust or needs repacking, refer to corrective maintenance.

(b) Pump air bound, not pumping, pump hot to touch: seen by operator on discharge pressure gage and felt by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually turn off power to pump drive motor by turning control switch to OFF. Vent air from pump housing when pump shaft stops turning by opening pump vent valve.

(c) Unit not pumping desired quantity of flow: seen by operator on discharge pressure gage.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Excessive seal water flow at packing gland: seen by operator.
ACT: tighten gland to reduce flow. If gland will not adjust to prevent leakage, repack pump. Look at sleeve wear while packing is out.
GEN ACT:
(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

Continued

(c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually close suction and discharge valves.

(c) Drain pump as specified in pump manufacturer's maintenance manual.

(d) Use grease gun to lubricate component with proper type and quantity of lubricant designated in manufacturer's instructions.

(e) Manually pull inspection plate to verify by observation that the impeller is not damaged (chipped, cracked, or clogged up). If damaged, refer to corrective maintenance.

(f) Manually replace inspection plate and open suction and discharge valves.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent flooding of immediate area which could cause injury to operator.

COMPRESSOR (Gas Recirculation)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: compressor running smoothly, normal noise level, low even hum, gear box temperature normal (can hold hand on gear box for at least 30 seconds), no hot spots on compressor casing, oil level normal as indicated on dip stick, drive belts running smoothly and in good condition, discharge pressure normal as indicated on pressure gage.
   ACT: operator inspects for the above characteristics.
   WHY: excessive temperature and/or vibration are indicators of mechanical abnormalities and must be investigated.

2. POSSIBLE MALFUNCTIONS

   (a) Excessive vibration: felt by operator.
   REF: compressor manufacturer's maintenance manual.
   IMM OP ADJ: cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.

   (b) Excessive gear box temperature (cannot hold hand on it for at least 30 seconds): felt by operator.
   REF: compressor manufacturer's maintenance manual.
   IMM OP ADJ: cut power to compressor drive motor; notify supervisor.

   (c) Hot spots on compressor casing: felt by operator.
   REF: compressor manufacturer's maintenance manual.
   IMM OP ADJ: cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.
   WHY: hot spots indicate increased friction inside the case which in turn indicates a build up of foreign material or mechanical misalignment.

   (d) Oil leaks: seen by operator.
   REF: compressor manufacturer's maintenance manual.
   IMM OP ADJ:
   (1) Large leaks--cut power to compressor drive motor and notify supervisor.
   WHY: low oil levels can cause extensive mechanical damage.
   (2) Small leaks--none.

   (e) Drive motor and compressor misalignment: visually observed by operator, or indicated by rapid wearing on drive belts.
   REF: compressor manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.
   WHY: misalignment of drive unit and belts places abnormal stress on compressor components and will cause excessive wear.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF, start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.

(2) Tighten connections with screwdriver.

(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

Continued

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

COUPLING (Sludge Recirculation)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: coupling running smoothly and quietly; motor, drive and pumps are in straight line and connecting bolts are intact.
   ACT: operator listens for unusual sounds (grinding, jerking) when component is running and looks at coupling bolts and alignment when component is not running; operator looks and/or listens for vibrations while motor is running.

2. POSSIBLE MALFUNCTIONS

   (a) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate pump according to plant developed operational manual. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: quarterly
   COND: none.
   GEN ACT:

   (a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Avoid putting hands behind safety screen that encloses coupling while inspecting for any damage due to wear. If coupling worn badley, refer to corrective maintenance.

   (c) Use grease gun to lubricate coupling with proper type and quantity of lubricant as called for in manufacturer's maintenance manual.

   (d) Wipe up all spilled lubricant with rags and/or absorbent.

   (e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (f) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Avoid putting hands behind safety screen that encloses coupling while inspecting for damage.
WHY: rapidly rotating parts can do major physical harm to hands.

(c) Wipe up all spilled lubricant with rags and/or absorbent.
WHY: to prevent slippery conditions and possible falls.

PUMP (Centrifugal, Sludge Recirculation)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: pump turning at normal speed (determined from previous experience). Discharge pressure within limits indicated on name plate. Temperature of bearings normal (can hold hand on bearing housing for at least 30 seconds). No unusual noises such as grinding, squealing, clanking or any excessive vibration. Packing gland dripping very little (film of water on floor).
ACT: operator determines temperature of bearings with fingers and notes vibration level at the same time. He observes packing gland dripping slightly and listens for unusual noise. Operator observes pressure gage to determine pressure.

2. POSSIBLE MALFUNCTIONS

(a) Excessive leakage at packing gland (stream of sludge leaking): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: adjust packing gland by tightening nuts equally to reduce flow to proper level. If gland will not adjust or needs repacking, refer to corrective maintenance.

(b) Pump air bound, not pumping and pump hot to touch: seen by operator on discharge pressure gage and felt by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: turn off power to pump drive motor by turning control switch to OFF. Vent air from pump housing when pump shaft stops turning by opening pump vent valve.

(c) Component not pumping desired quantity of flow: seen by operator on discharge pressure gage.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: weekly.
COND:
(a) Excessive seal water flow at packing gland (stream of sludge leaking): seen by operator.
ACT: tighten gland to reduce flow (1/4 turn alternate bolts until leak is a slow drip). If gland will not adjust to prevent leakage, repack pump.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually close suction and discharge valves.

(c) Drain pump as specified in pump manufacturer's maintenance manual.

(d) Use grease gun to lubricate component with proper type and quantity of lubricant designated in manufacturer's instructions.

(e) Manually pull inspection plate (open pump case) to verify by observation that the impeller is not damaged (chipped, cracked or clogged up). If damaged, refer to corrective maintenance.

(f) Manually replace inspection plate and open suction and discharge valves.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

Continued

Pump (Centrifugal, Sludge Recirculation)--Continued

(b) Close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent flooding of immediate area which could cause injury to operator.

MOTOR (Gas Recirculation Compressor)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate, free of vibration, running with normal even humming sound, shaft turning, and bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if unit is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen and/or heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switch gear. If, when reset, motor won't run manually, turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

   (b) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance and notify supervisor.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Notify supervisor and refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn pump motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could damage equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

Continued

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury to operator.

COUPLING (Gas Recirculation)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: coupling running smoothly and quietly; motor, drive, and pumps are in straight line and connecting bolts are intact.
   ACT: operator listens for unusual sounds when component is running and looks at coupling bolts and alignment when component is not running; operator looks for vibrations while motor is running.

2. POSSIBLE MALFUNCTIONS

   (a) Sheared coupling: seen by operator.
   REF: coupling manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF, divert flow to alternate unit. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: coupling manufacturer's maintenance manual.
   FREQ: quarterly.
   COND: none.
   GEN ACT:
   (a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (b) Avoid putting hands behind safety screen around coupling while inspecting for possible wear of coupling.

   (c) Use grease gun to lubricate coupling with proper type and quantity of lubricant as called for in manufacturer's maintenance manual.

   (d) Wipe up all spilled lubricant with rags and/or absorbent.

   (e) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

   (f) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Coupling (Gas Recirculation)

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Avoid putting hands behind safety screen around coupling while inspecting for coupling wear.
WHY: to prevent major physical harms to hands due to the rapidly rotating parts.

(c) Wipe up all spilled lubricant with rags and/or absorbent.
WHY: to prevent slippery conditions and possible falls.

COMPRESSOR (Gas Recirculation)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: compressor running smoothly, normal noise level (low, even, smooth hum), gear box temperature normal (can hold hand on gear box for at least 30 seconds), no hot spots on compressor casing, oil level at normal mark, drive belts running smoothly and in good condition, discharge pressure reads normal.
ACT: operator feels gear box to see if temperature is too hot; listens and looks for unusual amount of vibration and listens for unusual noises. Operator looks at oil level indicator to determine actual level. If below mark, operator looks for small leaks, wipes down equipment, and notes leakage in future inspections. Operator visually observes discharge pressure from motor.
WHY: excessive temperature and/or vibration are indicators of mechanical abnormalities and must be investigated.

2. POSSIBLE MALFUNCTIONS

(a) Excessive vibration: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.

(b) Excessive gear box temperature (cannot hold hand on gear box for at least 30 seconds): felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor; notify supervisor.

(c) Hot spots on compressor casing: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.
WHY: hot spots indicate increased friction inside the case which in turn indicates a build up of foreign material or mechanical misalignment.

(d) Excessive oil leaks: seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor, notify supervisor, and refer to corrective maintenance.
WHY: low oil levels can cause extensive mechanical damage.

(e) Drive motor and compressor misalignment (often indicated by rapid wearing on drive belts): visually observed by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.
WHY: misalignment of drive unit and belts places abnormal stress on compressor components and will cause excessive wear.

Continued

3. PREVENTIVE MAINTENANCE
FREQ: semi-annually.
COND:
(a) Wear spots showing on impellers: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.

(b) Timing gear wear exceeds manufacturer's tolerance allowance: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.

GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Prevent open flames or smoking in areas that may contain digester gas (including digester roof top).
WHY: digester gas is flammable and may cause a fire or explosion.

(c) Inspect for preceding conditions in indicated manner. Refer any work that involves dismantling and reassembling of a compressor of this design to a qualified machinist.
WHY: reassembly and timing of lobed impellers requires specialized knowledge and tools.

(d) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) No smoking or open flames (welding, brazing, flame soldering, etc.) in areas that may contain digester gas (including digester roof top).
WHY: digester gas is flammable and may cause a fire or explosion which may result in death to engineer.

(b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

GAS METER (Production)

1. NORMAL PROCEDURE

FREQ: at least once every 8-hour shift.

COND: gas meter component dial is turning at normal speed (determined by previous experience).

ACT: operator looks at the gas meter and notes that the component dial is turning.

FREQ: once daily.

COND: none.

ACT: operator reads all the gas meter dials and records reading on the daily totalizer sheet. He then subtracts yesterday's reading from today's reading.

WHY: the daily amount of gas production of a digester is an important indication of how well the digester is operating.

2. POSSIBLE MALFUNCTIONS

(a) Gas meter component dial is not turning: seen by operator.

REF: plant operation manual.

IMM OP ADJ:

(1) Observe the valving to verify that the gas flow is valved through the meter.

(2) Observe the digester pressure manometer to verify that there is digester gas pressure.

(3) Observe the heat exchanger burner or waste gas for flame to verify that the gas is going through the gas meter.

(4) Notify supervisor if all the above items are satisfactory.

(b) Gas meter appears to be turning too fast (determined by plant record and experience): seen by operator.

REF: gas meter manufacturer's maintenance manual.

IMM OP ADJ: refer to corrective maintenance.

WHY: the meter damping fluid may have drained out which may cause damage to the motor.

3. PREVENTIVE MAINTENANCE

REF: gas meter manufacturer's maintenance manual.

FREQ: annually.

COND: none.

GEN ACT:

(a) Manually isolate the gas meter by valving the gas flow through the meter bypass line.

(b) Provide adequate ventilation.

(c) Disassemble the gas meter and clean as designated by the manufacturer's instructions.

Continued

(d) Assemble the gas meter, add damping fluid and manually valve the meter back in service.

(e) Look for leaks by painting joints with a soapy water solution. If leaks are observed, refer to gas meter manufacturer's maintenance manual for repair.

(f) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Provide adequate ventilation. WHY: accumulations of digester gas create an explosive/fire hazard which could kill the operator.

(b) Manually isolate the gas meter by valving the gas flow through the meter bypass line. WHY: to prevent possible exposure of gas to operator which could cause death.

GAS MANOMETERS

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: the digester gas dome **does** show a positive pressure indication on the gas manometer.
   ACT: operator observes that the liquid level in the digester gas dome leg of the "U" tube manometer is below the liquid level of the atmosphere leg.
   WHY: the digester might such in air and create an explosive mixture in the gas dome if a negative pressure condition should occur.

2. POSSIBLE MALFUNCTIONS

   (a) Digester gas pressure is in excess of determined limit (15 inches of water column): seen on manometer by operator.
   REF: plant operation manual.
   IMM OP ADJ: verify by observation that supernatant overflow is running freely, digester pressure relief valve works freely, waste gas burner line is open, and waste gas regulator works freely. If none of the above items cures the problem, notify supervisor.

   (b) Digester gas pressure shows a partial vacuum: seen on manometer by operator.
   REF: plant operation manual.
   IMM OP ADJ: manually shut off the main gas valve from the digester gas dome. Manually shut off any valves that might be draining liquid from the digester. Notify supervisor.
   WHY:
   (1) A negative gas dome pressure could create an explosive condition by sucking in air.
   (2) A negative pressure in the gas dome could cause the roof to collapse.

   (c) Water column is low in both legs: seen by operator.
   ACT: add water to "U" tube to raise liquid level to normal height.
   WHY: if the water levels get too low, the gas-water seal effect may be lost and digester gas will escape into the room creating a hazardous condition.

3. PREVENTIVE MAINTENANCE
   REF: plant operation manual.
   FREQ: monthly.
   COND:
   (a) "U" tube is dirty inside: seen by operator.
   ACT: manually turn off gas supply by closing valve; manually remove and clean the "U" tube with brush; add correct amount of liquid indicated by plant manual and put back into service.
   WHY: a dirty manometer might be misread.
   GEN ACT:
   (a) Manually shut off the main gas valve from the digester gas dome.

Continued

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary. Handle "U" tubes with care.

(c) Verify by observation that the gas-water seal is maintained. If not maintained, refer to corrective maintenance.

(d) Manually turn on the main gas valve from the digester gas dome.

(e) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Maintain the gas-water seal at all times. WHY: to prevent explosive gas from venting through the manometer "U" tube resulting in explosion injuring the operator.

(b) Avoid careless handling of "U" tubes. WHY: to prevent breakage of tubes causing serious cuts to operator.

GAS WATER TRAPS (Condensate)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: trap valve opens and closes as handle is moved; water drains from trap.
ACT: operator moves handle to "DRAIN" and observes flow of water from component.

2. POSSIBLE MALFUNCTIONS

(a) Valve does not move when handle is moved: visually observed by operator.
REF: trap manufacturer's manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.

(b) Gas leakage when valve handle is at "DRAIN" position or "FILL" position: seen or smelled by operator.
REF: trap manufacturer's manual.
IMM OP ADJ: manually close isolation valve, notify supervisor, and refer to corrective maintenance.
WHY: escaping gas could ignite, causing an explosion or fire.

3. PREVENTIVE MAINTENANCE
REF: trap manufacturer's manual.
FREQ: semi-annually.
COND:
(a) Water not draining freely from trap: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.
GEN ACT:
(a) Manually close isolation valve.
WHY: to minimize leakage of gas when trap is removed from system.

(b) Manually remove the trap and disassemble the parts.

(c) Clean the trap with high pressure hose and scraper.

(d) Reassemble the parts and manually replace the trap.

(e) Minimize leakages of gas when removing or replacing trap.

(f) Inspect for gas leaks.

(g) Manually open the isolation valve.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Manually close isolation valve and repair any component leaking gas.
WHY: to prevent over-exposure of gas to operator which could cause sickness or death.

(b) Minimize leakages of gas when removing or replacing trap.
WHY: to minimize danger of explosion or fire causing injury to operator.

GAS REGULATOR (Pressure)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: the gas pressure regulator is controlling the digester gas dome pressure.
   ACT: the operator observes that the gas pressure regulator is controlling the digester gas dome pressure by regulating the flow of gas to the waste gas burner (seen by operator on digester gas pressure manometer).

2. POSSIBLE MALFUNCTIONS

   (a) The gas pressure regulator maintains too much gas pressure in the digester gas dome: seen by operator on digester gas pressure manometer.
   REF: gas regulator manufacturer's maintenance manual.
   IMM OP ADJ: the operator verifies by observation that the gas regulator is maintaining itself in the open position, the supernatant overflow is running freely, and the waste gas burner line is open. If this does not cure the problem, notify supervisor.
   WHY: too much digester gas pressure may cause the gas to vent out the digester pressure relief valve.

   (b) The gas pressure regulator maintains too little gas pressure in the digester gas dome: seen by operator on gas pressure manometer.
   REF: gas regulator manufacturer's maintenance manual.
   IMM OP ADJ: the operator makes sure that the gas regulator is maintaining itself in the closed position, there is no liquid draining from the digester, and the waste gas burner flame is OUT. Notify supervisor if problem is not located.

3. PREVENTIVE MAINTENANCE
   REF: gas regulator manufacturer's maintenance manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Complete the preventive maintenance work as soon as possible.
   WHY: excess gas must vent out the digester gas dome pressure relief valve while the waste gas burner is out of service creating an odor and explosive atmosphere.

   (b) Manually valve off the gas pressure regulator valve and provide adequate ventilation.

   (c) Manually disassemble the gas regulator valve, completing the work as quickly as possible.

   (d) Clean and renew parts as needed (pinholes look worn) paying close attention to the diaphram disc.

   (e) Manually reassemble the gas regulator valve.

Continued

Gas Regulator (Pressure)--Continued

(f) Valve on the gas pressure regulator valve.

(g) Inspect for gas leaks by painting the joints with soapy water. If leaks are present, repair as indicated by gas regulator manufacturer's maintenance manual.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually valve off the gas pressure regulator valve.
WHY: to prevent over exposure of gas to operator which could cause sickness or death.

(b) Provide adequate ventilation.
WHY: to minimize danger of explosion, fire, or poisoning which could injure or kill operator.

GAS PRESSURE AND VACUUM RELIEF VALVES (Digester Cover)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: digester gas pressure within normal range (8 to 12 inches water column), pressure relief valve closed, vacuum relief valve closed.
   ACT: operator observes digester gas pressure, notes that the pressure relief valve and vacuum relief valve are closed. Operator sniffs downward from relief valve to detect any leaking gas; notifies supervisor if leaks are detected.

2. POSSIBLE MALFUNCTIONS

   (a) Valves leaking gas: smelled by operator.
   REF: valve manufacturer's manual.
   IMM OP ADJ: inspect by observation the digester gas manometer pressure.
   (1) If normal (not exceeding setting of pressure relief valve), notify supervisor and refer to corrective maintenance.

   (2) If manometer pressure is above pressure setting on relief valve, stop all pumping into the digester and inspect supernatant overflow line. If it is flowing freely, inspect all digester operating procedures to determine cause of increased pressure. Notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Provide for alternate pressure relief control or vent digester to atmosphere.

   (b) Verify by observation that there are no open lights or smoking when work is being performed on digester roof.

   (c) Manually remove and disassemble component.

   (d) Inspect valve faces, seats, guides, spring tension, and weights. Repair or adjust as necessary.

   (e) Reassemble component and install.

   (f) Inspect for odors and/or sound of leaking gas. Refer to corrective maintenance if a leak is found.

   (g) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Gas Pressure and Vacuum Relief Valves (Digester Cover)--Continued

4. MAJOR SAFETY FACTORS

(a) Provide for alternate pressure relief control or vent digester to atmosphere.
WHY: to prevent build-up of pressure which could cause explosion killing operator.

(b) Verify by observation that there are no open lights or smoking when work is being performed on digester roof.
WHY: to prevent ignition of digester gas causing an explosion or fire which could injure or kill operator.

FLAME ARRESTORS (Gas Piping)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: normal operation of components (flame from burners) downstream from flame arrestor (indicates a free flow of gas through the flame arrestor). Pressure drop across the component is normal (if pressure gages are installed immediately before and after component in line as indicated by previous experience).
ACT: operator observes normal operation of components downstream from flame arrestor. Operator observes the pressure drop across the component by reading the gages installed immediately before and after component.
WHY: abnormal pressure drop indicates flow restriction.

2. POSSIBLE MALFUNCTIONS

(a) Flow restricted through component by accumulation of foreign materials, indicated by abnormal pressure drop through component: seen by operator.
REF: flame arrestor manufacturer's manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance for cleaning.

3. PREVENTIVE MAINTENANCE
REF: manufacturer's maintenance manual.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Provide ventilation sufficient to remove any accumulation of gas due to opening gas piping.

(b) Isolate flame trap by valving off.

(c) Manually disassemble component.

(d) Manually clean internal parts and seal faces with soap, water, and/or safety solvent.

(e) Manually reassemble component.

(f) Put component in service by opening valves.

(g) Inspect seal areas for gas leaks by daubing soap suds along gasket edges and around bolt heads. If leak found, refer to corrective maintenance.
WHY: accumulations left in component for long periods of time will corrode internal parts and make cleaning very difficult.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Flame Arrestors (Gas Piping)--Continued

4. MAJOR SAFETY FACTORS

(a) Provide adequate ventilation in area.
WHY: to prevent accumulations of digester gas which could create a potential explosion and/or fire causing injury or death to operator.

RAW SLUDGE FLOW METER (Magnetic)

1. NORMAL PROCEDURES
   FREQ: at least once every 4 hours.
   COND: all pipe flanges and couplings secure and not leaking, electrical supply conduits and fittings sound, component not subject to vibrations from attached pumps and piping.
   ACT: visually observe, place hand on component to feel for vibration, observe flow indication of flow chart, look for leaking around couplings and loose electrical conduits and fittings.
   WHY: loose piping, leaks, excessive vibration must be corrected to prevent further damage to the system. Abnormal flow indications, if not representative of flow conditions, must be corrected to prevent faulty information from being given to the process analyst.

2. POSSIBLE MALFUNCTIONS

   (a) Loose pipe fittings (vibration or leaks): observed by operator.
   REF: flow meter manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

   (b) Grease covered internal sensors (indicated by low flow reading when tested with a known flow or seen during internal inspection): seen by operator.
   REF: flow meter manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor.
   WHY: meter should be cleaned to provide accurate flow readings.

   (c) No flow indication: observed by operator.
   REF: flow meter manufacturer's maintenance manual.
   IMM OP ADJ: inspect power supply switch to meter. If it is off and not tagged contact supervisor for permission to turn it on. If it is on or does not function properly when turned on, notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Grease covered internal sensors (indicated by low flow reading when tested with a known flow or seen during internal inspection): seen by operator.
   ACT: clean the sensors as indicated by the flow meter manufacturer's maintenance manual.
   GEN ACT:
   (a) Open power switch to valves.

   (b) Divert flow to by-pass piping by use of valves.

Continued

(c) Isolate by valving around meter and flush component with hot water until it is clean.

(d) Drain component to sump by opening valve.

(e) Manually remove piping end caps.

(f) Visually inspect sensor area.

(g) Manually remove grease with wooden scraper if necessary. Scrub sensors with detergent and stiff bristle brush.

(h) Manually replace pipe caps.

(i) Close the drain valve.

(j) Put component in service by switching power to valves and observe operation.

(k) Visually inspect for leaks around pipe caps.

(l) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: annually.
COND: none.
GEN ACT:

(a) Instrument technician thoroughly inspects unit for flow calibration accuracy and makes adjustments as necessary.
WHY: inaccurate flow readings could mislead the operator and cause him to make inappropriate operations decisions in running his plant.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Close inlet and outlet valves on meter before removing pipe cap retainers.
WHY: to prevent flooding which could be hazardous to operator.

RAW SLUDGE DENSITY METER (Nuclear)

1. NORMAL PROCEDURES
   FREQ: at least once every 4 hours.
   COND: all pipe flanges and fittings secure and not leaking, electrical conduits and fittings sound, component not subject to vibrations from pumps and attached piping.
   ACT: visually observe for leaks, feel for vibration, observe sludge density indication, look for loose conduits and fittings.
   WHY: loose piping, leaks, excessive vibration must be corrected to prevent further damage to the system. Abnormal density indications, if not representative of density conditions, must be corrected to prevent faulty information from being given to the process analyst.

2. POSSIBLE MALFUNCTIONS

   (a) Loss of density indication: observed by operator.
   REF: density meter manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor.

   (b) Loose pipe fittings (vibration or leaks): observed by operator.
   REF: density meter manufacturer's maintenance manual.
   IMM OP ADJ: refer to corrective maintenance.

   (c) Indicated densities trending away from densities found by lab tests (noted by comparison of lab tests and indicated density taken at the time samples were drawn): seen by operator.
   REF: density meter manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
   REF: manufacturer's maintenance manual.
   FREQ: monthly.
   COND:
   (a) Meter internal surfaces grease covered, indicated density trending from lab samples (indicated by low flow reading when tested with a known flow or seen during internal inspection): seen by operator.
   ACT: clean the sensors as indicated by the flow meter manufacturer's maintenance manual.
   GEN ACT:
   (a) Divert flow to by-pass piping by use of valves.

   (b) Isolate component by valving off and flush with clean water.

   (c) Drain component by opening drain valve.

   (d) Manually remove pipe caps for inspection.

   (e) Verify by observation that all personnel working on density meter are wearing radiation monitoring badges. Provide badges if necessary.
   WHY: to maintain records of long term radiation exposure for each individual.

Continued

(f) Manually close lead gate on nuclear source and prevent placing any portion of body in the source radiation area.

(g) Visually inspect sensor area.

(h) Scrub with detergent or steam (if allowed by manufacturer) interior of unit to remove grease.

(i) Manually replace pipe caps.

(j) Close drain valve.

(k) Manually open valves and mechanically open lead gate on source.

(l) Calibrate component to manufacturer's specifications with work by instrument technican.

(m) Return component to service by switching valves and observe operation to verify standard operation.

(n) Visually inspect for leaks around pipe caps.

(o) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Verify by observation that all personnel working on density meter are wearing radiation monitoring badges. Provide badges if necessary. Inspect records of radiation exposure for each individual.
WHY: to prevent sickness or death due to too much radiation in a short period of time.

(b) Divert flow to by-pass piping by use of valves.
WHY: to prevent contact of sludge with operator which could cause sickness of or infection to operator.

DIGESTER INTERNAL PIPING (Gas Mixing)

1. NORMAL PROCEDURE

FREQ: at least once every 8-hour shift.
COND: all pipe fittings tight, back-pressure on sparger system within limits determined by previous operating experience.
ACT: operator feels piping for excessive vibration and looks at the back-pressure gage reading.
WHY: excessive vibration may break pipes. High or low sparger pressure indicates that problems are developing in the gas-mixing system.

2. POSSIBLE MALFUNCTIONS

(a) High sparger back-pressure (gage reading): seen by operator.
REF: gas mixing component manufacturer's manual.
IMM OP ADJ: verify that the gas inlet valves are fully open. If valves are fully open, notify supervisor.
WHY:

(1) Gas piping may be plugged with foreign material which could cause rapid build-up of pressure thus producing an explosion.

(2) Sparger heads may be plugged with digester solids.

(b) Low sparger back-pressure (gage reading): seen by operator.
REF: gas mixing component manufacturer's manual.
IMM OP ADJ: manually shut down gas mixing component by turning control switch to OFF. Notify supervisor.
WHY: sparger supply piping may be broken inside the digester causing excessive damage if not shut down.

(c) Excessive vibration in gas mixing piping: seen, felt, or heard by operator.
REF: gas mixing component manufacturer's manual.
IMM OP ADJ: manually shut down gas mixing component by turning control switch to OFF. Notify supervisor.

3. PREVENTIVE MAINTENANCE

REF: manufacturer's maintenance manual.
FREQ: semi-annually.
COND:

(a) Loose or broken pipe hangers or brackets: seen and felt by operator.
ACT: tighten, repair or replace faulty hangers and brackets as indicated in manufacturer's maintenance manual.
WHY: poor support could lead to broken piping.

(b) Plugged sparger piping in digester (indicated by back-pressure increase since last cleaning): seen by operator.
ACT: manually remove sparger components from digester, clean, repair as necessary, reinstall as indicated in manufacturer's maintenance manual.
WHY: plugged components reduce efficiency of mixing in digester.

Continued

GEN ACT:
(a) Manually cut power to gas compressor.

(b) Inspect for preceding conditions and repair if needed as indicated by manufacturer's maintenance manual.

(c) Manually cut power on to gas compressor.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicated equipment replacement time.

FREQ: when digester is emptied for cleaning.
COND: none.
GEN ACT:
(a) Manually cut power to gas compressor.

(b) Verify by observation that there is no smoking or other open flames in area.

(c) Provide ventilation in empty digester before entering to make inspection.

(d) Visually inspect draft tube for structural soundness, bolts tight, and secured firmly to floor of digester. If necessary, tighten bolts and secure firmly to floor of digester.

(e) Visually inspect surfaces of draft tube to verify smoothness to prevent accumulation of rags. Perform maintenance as indicated in maintenance manual if surfaces need to be smoothed.

(f) Clean out supernatant line by flushing with high pressure water hose.

(g) Manually cut power on to gas compressor.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually cut power to gas compressor when working on system.
WHY: accidental start-up may cause injury to personnel.

(b) No smoking or other open flames in area.
WHY: digester gases will burn and/or explode in the presence of fire causing injury or death to operator.

(c) Provide ventilation in empty digester before entering to make inspection.
WHY: low oxygen levels, toxic or noxious gases may cause sickness to or death of operator.

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURES

FREQ: at least once every 8 hours.
COND: fire fighting equipment in proper place as designated by supervisor and has been inspected within the last month by plant fire marshal.
ACT: operator looks at inspection tag of fire fighting equipment; if inspection time has elapsed, operator notifies supervisor. Operator observes where fire fighting equipment is hanging or placed.
WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

(a) Equipment missing: seen by operator.
REF: none.
IMM OP ADJ: notify supervisor.

(b) Equipment damaged: seen by operator.
REF: fire fighting equipment maintenance manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE

REF: fire fighting maintenance manual.
FREQ: annually.
COND:
(a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
GEN ACT:
(a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
WHY: low weight indicates extinguisher should be recharged.

(b) Observe pressure gage on extinguisher (dry chemical) to verify that needle is pointing in position that shows pressure is not low.

(c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRST AID KIT

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: first aid kit in proper place as designated by supervisor and contains proper supplies listed on inventory sheet in kit.
ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies and notes location of kit.
WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

(a) Kit is missing: seen by operator.
REF: none.
IMM OP ADJ: notify supervisor and replace it with new kit.

(b) Kit is damaged (case will not close; water, rodents contaminate supplies): seen by operator.
REF: first aid kit manual.
IMM OP ADJ: notify supervisor and replace or repair kit.

3. PREVENTIVE MAINTENANCE
REF: first aid kit manual or supply list.
FREQ: at least once every week.
COND:
(a) Some supplies missing: seen by operator.
ACT: determine actual amount of supplies missing.
GEN ACT:
(a) Replenish first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

TRAINEE WORKBOOK

ROUTINE PLANT OPERATIONS PO-I

SECOND STAGE DIGESTION

Criteria for the Establishment & Maintenance
of Two Year Post High School Wastewater
Technology Training Programs

U. S. Environmental Protection Agency
Office of Water Program Operations
Academic Training Branch

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Clemson, South Carolina

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Editorial work on the second draft of this manual was carried out by John S. Cox, Senior Class Research Assistant, Environmental Systems Engineering, Clemson University.

SECOND STAGE DIGESTION

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START-UP PROCEDURE FOR PROCESS

1. Allow no smoking or open flames in the digester area.

2. Inspect the inside of the digester as follows:

   (a) Provide adequate ventilation in all areas.

   (b) Verify by observation that the inside of the digester is free of tools, ladders, or any extraneous debris.

   (c) Verify by observation that all internal piping joints are tight, piping is in place and securely fastened at the support points, and that all bolts are tight.

   (d) Look into or run air or water through all piping to verify that all lines are open.
   WHY: once the digester is full of liquid, the inside piping will be inaccessible.

   (e) Verify by observation that all personnel are clear of the unit and are aware of the start-up.
   WHY: to prevent injury to personnel.

3. Inspect the outside of the digester as follows:

   (a) Verify by observation that all piping joints are tight, piping is in place and securely fastened at the support points, and that all bolts are tight.

   (b) Run air or water through all piping to verify that all lines are open.

   (c) Manually turn all valves to verify that they turn freely.
   WHY: if there are valve or piping malfunctions once the digester is full of liquid, it would be necessary to drain the digester to to repair work.

4. Inspect all components of the digester external equipment for power available [indicating lights on (power)], piping clean and solidly anchored, valves properly positioned (valves not in backwards), couplings tight and aligned, pumps packed and water flow to packing. External components are digested sludge pump, variable speed drive and motor, piping and valves, gas meter, gas manometers, gas water traps, gas pressure and vacuum relief valves, flame arrestors, floating cover, gas compressor, gas storage tanks.
   WHY: once the digester is in operation, a malfunction of certain pieces of external equipment will impede or stop the digester operation.

5. Fill the digester with raw sewage to the normal operating level as determined by the supernatant overflow as follows:

   (a) Manually open the raw sewage inlet valve to the raw sludge pump suction.

   (b) Manually open the discharge valve from the raw sludge pump to the digester.

Continued

(c) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn raw sludge pump motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(d) Manually stop the raw sludge pump by turning the control switch to OFF when the raw sewage begins to flow out the supernatant line.

(e) Visually inspect for liquid leaks. Repair any leaks found by referring to corrective maintenance. (Prevent sludge from splashing in the eyes, ears, nose, or mouth.)

(f) Use raw sewage instead of raw sludge to fill the digester.
WHY:
(1) Raw sludge will cause the digester to immediately go into an overloaded state.
(2) Raw sewage is easier tohandle in case the digester had to be drained right away for repair work.

6. Seal as directed by plant operation manual all digester openings including gas lines, pressure relief vent, inspection manholes, supernatant lines, sludge feed lines, digested sludge draw-off lines.

7. Using a water column pressure indicator, slowly pressurize the digester gas dome to 15-18 inches (check design data) of water column using compressed air as follows:

(a) Paint joints and gasket seals with a soapy solution and look for soap bubbles.

(b) Verify by observation that the digester maintains a minimum time statis pressure loss as specified by the design data. If it does not, refer to corrective maintenance.

(c) Use water column pressure indicator to verify that the digester gas pressure relief vent will open at 15 inches (verify by design data) of water column.
WHY: digester gas leaks could cause an explosion/fire hazard.

8. Unseal all digester openings necessary for normal operation including: sludge lines, pressure relief vent, gas lines, and supernatant lines. Reconnect any lines that had been disconnected during the sealing process when hunting for gas leaks.

9. Fill (as directed by plant operation manual) the gas manometer with water to the "ZERO" level marks. Add a drop of red food coloring to each leg of the manometer to make water level easier to see.

10. Valve primary supernatant overflow to secondary digester.

11. Allow digester gas dome to vent to the atmosphere through the pressure relief valve.

Continued

12. Follow process control's instructions while bringing the digester into normal operation.

13. When the gas production is 40 percent or less CO_2, purge the gas piping to the main gas header, then valve the secondary gas production into the main gas header.

MAJOR SAFETY FACTORS

(a) Allow no smoking or open flames in the digester area.
WHY: digester gases are flammable and/or explosive when ignited causing injury or death to operator.

(b) Allow no sludge to splash in eyes, ears, nose, or mouth. Flush area with fresh water if sludge is accidentally splahsed on body.
WHY: high bacterial content of sludge may cause disease to operator.

(c) Provide adequate ventilation in all areas.
WHY: digester gas can be poisonous in even small amounts to operator causing sickness or death.

SHUT-DOWN PROCEDURE FOR PROCESS

1. Allow no smoking or open flames in digester area.

2. Manually valve the primary digester supernatant flow so that it returns to the plant headworks. (This should be done at least 24 hours before digester draining procedures begin.)
   WHY: to allow stratification of digester contents and to reduce gas production.

3. Withdraw all digested sludge to the digested sludge handling unit (drying beds, vacuum filter, centrifuge, and other components) by manually opening bottom draw-off valve from secondary digester and pumping with digested sludge pump through appropriate valving to unit.

4. When all the digested sludge has been withdrawn, manually valve the bottom draw-off flow to return to the plant headworks.

5. When the digester cover is within 12" of the corbels, manually valve off the gas line from the gas dome and tag the valve "closed, do not open."

6. Manually open all the hatch covers in the floating cover and provide forced ventilation for the gas dome.

7. Continue to drain the secondary digester to the headworks until the scum blanket is reached.

8. Valve the bottom draw off to the digested sludge pump and pump the scum to the multiple hearth incinerator unit.
   WHY: scum will plug any further treatment unit except the incinerator.

9. When the level of sludge is below the side wall access port, using rocket wrench undo bolts and remove hatch cover to provide ventilation and better inspection of the bottom materials. Allow no smoking or open flames within 30 feet of the open port.

10. From the side wall access port, use high pressure hose to hose down all interior surfaces, piping, and other components. [Do not enter the digester until provisions (forced air ventilation fans and air hoses to ventilate digester interior) have been set up for high volume, forced air ventilation. Toxic or suffocating gases may overcome personnel if fresh air is not provided.]

11. When personnel are ready to enter the digester, provide, in addition to ventilation, safety harnesses and lines tended by a man watching from the access port. If a ladder is used, tie a line to its top rung and secure the line firmly outside the digester. If an extension ladder is used, extend ladder to length needed and tie overlapping rung areas securely to prevent loss of lower section in digester. (Allow no sludge to splash in eyes, ears, nose, or mouth.)

Continued

Shut-Down Procedure for Process--Continued

12. Using water to slurry bottom contents and a trash pump to remove the material and transport it to holding lagoons, remove, dispose, and proceed until digester is empty. (This project can be undertaken by plant personnel or contracted to outside companies. Sand can be disposed of by burial, landfill, or other means.)

13. Finish hosedown of digester interior. Remove by hand all hanging strings of rags, and other debris from piping, pipe hangers, and brackets.

14. Visually inspect all interior piping, hangers, supports, footings for signs of failure or deterioration. Record all findings for reference at future inspections. Repair or replace any equipment showing indications of advanced deterioration. (Use caution while dismantling digester piping.)

15. For any components needing repair, manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

MAJOR SAFETY FACTORS

(a) Allow no smoking or open flames in digester area.
WHY: digester gases are flammable and/or explosive when ignited causing severe burns, injury, and possible death to operator.

(b) Allow no sludge to splash in eyes, ears, nose or mouth. Flush area with fresh water if accidentally splashed.
WHY: high bacterial content of sludge may cause disease of operator.

(c) For any component needing repair, manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(d) Use caution while dismantling digester piping.
WHY: iron sulfide oxidizes rapidly on contact with atmospheric oxygen causing possible heat or flame which could injure operator.

(e) Provide adequate ventilation in all areas.
WHY: to prevent sickness or death of operator due to build of gas.

GENERAL ORDER FOR PERFORMING NORMAL OPERATION PROCEDURE

Component/Step	Frequency
1. Motor (Digested Sludge Pump Drive)	every 4 hours
2. Variable Speed Drive (Digested Sludge Pump)	" " "
3. Digested Sludge Pump (Piston Type, Belt Driven)	" " "
4. Gas Manometers	" " "
5. Floating Cover	" " "
6. Motor (Gas Storage Compressor)	" " "
7. Gas Storage Compressor (Piston Type, Belt Driven)	" " "
8. Piping and Valves	every 8 hours
9. Gas Meter (Production)	" " "
10. Gas Water Traps (Condensate)	" " "
11. Gas Pressure and Vacuum Relief Valves (Digester Cover)	" " "
12. Flame Arrestors (Gas Piping)	" " "
13. Gas Storage Tanks	" " "
14. First Aid Kit	" " "
15. Fire Fighting Equipment	" " "
16. Gas Meter (Production)	" " "

GENERAL ORDER FOR PERFORMING PREVENTIVE MAINTENANCE PROCEDURE

	Component/Step	Frequency
1.	Variable Speed Drive (Digested Sludge Pump)	weekly
2.	Floating Cover	weekly/semi-annually
3.	First Aid Kit	weekly
4.	Motor (Digested Sludge Pump Drive)	monthly
5.	Digested Sludge Pump (Piston Type, Belt Driven)	monthly/annually
6.	Piping and Valves	monthly/semi-annually
7.	Gas Manometers	monthly
8.	Motor (Gas Storage Compressor)	"
9.	Gas Water Traps (Condensate)	semi-annually
10.	Flame Arrestors (Gas Piping)	"
11.	Gas Storage Compressor (Piston Type, Belt Driven)	"
12.	Gas Meter (Production)	annually
13.	Gas Pressure and Vacuum Relief Valves (Digester Cover)	"
14.	Gas Storage Tanks	"
15.	Fire Fighting Equipment	"

ABNORMALS AND PROBABLE CAUSES FOR PROCESS

OBSERVED ABNORMALS OF WASTESTREAM

1. Supernatant

   (a) Foaming: seen by operator.
   CAUSE:
   (1) Scum blanket breaking up.
   (2) Increase in digester contents' temperature after a prolonged period of lower temperature.

   (b) Lumps and particles of scum: seen by operator.
   CAUSE:
   (1) Scum blanket breaking up.
   (2) Scum blanket too deep (below highest supernatant pipe).

   (c) Gray or brown color (different than normal black color): seen by operator.
   CAUSE:
   (1) Inadequate stratification of digester contents.
   (2) Digester ecological balance upset.

   (d) Sour odor: smelled by operator.
   CAUSE:
   (1) pH of digester contents too low.
   (2) Inadequate digestion.

2. Digester Gas

   (a) Poor quality gas (CO_2 percentage over 40%): seen by operator from test results.
   CAUSE:
   (1) Digester ecological balance upset.

3. Digested Sludge

   (a) Gray or brown color (different than normal black color): seen by operator.
   CAUSE:
   (1) Inadequate digestion.
   (2) Poor stratification of digester contents.

   (b) Sour odor (different from normal tar odor): smelled by operator.
   CAUSE:
   (1) pH of digested sludge too low.
   (2) Inadequate digestion.

Continued

Abnormals and Probable Causes for Process--Continued

4. Digester Scum Blanket (as determined from profile tests through digester cover thief hole)

   (a) Scum blanket more than one foot thick: seen by operator.
   CAUSE:
   (1) Undigested scum being carried over in the primary supernatant.
   (2) Lack of mixing equipment in the secondary digester. (Generally supplied but not generally used because prime purpose of secondary is stratification.)

NORMAL SAMPLING AND RELATED SAFETY FACTORS FOR PROCESS

NORMAL SAMPLING

1. Grab--supernate

   FREQ: at least once a day
   ACT: use a clean sampling apparatus of at least one liter capacity. Collect at discharge from digester at midpoint of pumping cycle. Deliver immediately to laboratory.

2. Grab--digester gas

   FREQ: at least once a day.
   ACT: attach intake of gas analyzer to spigot. Perform analysis as designated by laboratory analysis section. Close spigot, remove analyzer.

3. Grab--profile sampling

   FREQ: at least once every 6 months.
   ACT: lower sampler through thief hole to various depths at intervals of four feet. Deliver samples to laboratory immediately. At same time measure and record the depth of the scum blanket.

4. Grab--digested sludge

   FREQ: when withdrawing sludge.
   ACT: using clean sampling apparatus of 1 liter capacity, collect at discharge point in mid discharge pumping cycle. Deliver immediately to laboratory.

MAJOR SAFETY FACTORS

(a) Do not allow sludge, supernate, or scum to get into any body orifices or wounds.
WHY: pathogenic bacteria are present and severe illness or death could result.

(b) Use disinfectant soap for washup immediately after collecting any samples.
WHY: disease bacteria are present and infection could result.

(c) Do not smoke or have any open flame or possible spark producing materials near the digester.
WHY: highly explosive mixtures of digester gas and air can be obtained while sampling.

(d) Use safety ladders and harnesses in high danger areas.
WHY: falls can kill.

(e) Use plenty of ventilation in all areas.
WHY: digester gases can be toxic in small concentrations.

NORMAL PROCEDURE, POSSIBLE MALFUNCTIONS, PREVENTIVE MAINTENANCE AND RELATED SAFETY FACTORS BY PROCESS COMPONENT

MOTOR (Digested Sludge Pump Drive)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: motor only warm, running with low even hum, free of vibration, shaft turning, bearing temperature normal (can hold hand firmly on bearing housing for at least 30 seconds).
ACT: operator turns control switch to ON(HAND) (if component is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

(a) Motor won't run (shaft not turning): seen and/or heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switch gear. If, when reset, motor won't run manually, turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

(b) Motor too hot (can't hold hand firmly on motor for at least 30 seconds): felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: turn off power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance before proceeding.

(c) Excessive vibration: seen and/or felt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

(d) Unusual noise: heard by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

(e) Scorched paint or black stains on motor housing: seen by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelt by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Cracked or chipped paint and/or concrete around motor base: seen by operator.
ACT: tighten motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will cause damage to motor bearings and attached equipment resulting in high repair costs and excessive down time.

(b) Scorched paint and/or smoke stains and smoke: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on the name plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arching from loose connections could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will cause misalignment and consequent motor damage.

Continued

(e) Use grease gun to apply proper amount and types of lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong type of lubricant or improper quantity can damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags and/or absorbent.
WHY: lubricant will collect dirt and create a fire hazard

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in area that is difficult to reach.
WHY: to prevent falls and resulting injury.

VARIABLE SPEED DRIVE (DIGESTED SLUDGE PUMP)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: running quietly with no vibration.
   ACT: operator feels and listens to drive component.

2. POSSIBLE MALFUNCTIONS

   (a) Rattling or thumping noises: heard by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to unit drive motor by turning control switch to OFF and start alternate pump. Notify supervisor and refer to corrective maintenance.

   (b) Motor turning, output shaft of drive not turning: seen by operator.
   REF: drive manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF and start alternate pump. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: drive manufacturer's maintenance manual.
   FREQ: weekly.
   COND:
   (a) Worn belt (cracked or frayed): seen and/or heard by operator.
   ACT: notify supervisor and refer to corrective maintenance.
   GEN ACT:
   (a) While drive is running, manually turn selector wheel to highest speed position.

   (b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
   WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

   (c) Remove inspection plate by prying off with screwdriver.

   (d) Inspect belt and pulleys by observation while prodding belt with screwdriver.

   (e) Manually replace inspection plate.

   (f) Use grease gun to lubricate with correct amount of proper lubricant as designated by drive manufacturer's maintenance manual.

   (g) Clean up spilled lubricant with rags and/or absorbent.

Continued

Variable Speed Drive (Digested Sludge Pump)--Continued

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) While component is running, move speed selector through entire speed range.
WHY: changing speed setting while drive is not running will damage drive.

(j) Enter all preventive maintenance on equipment record card.
WHY: to show work performend for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Replace inspection plate before starting motor.
WHY: to avoid possibility of operator being mangled by belt and pulleys.

(c) Use screwdriver while inspecting belts.
WHY: to prevent loss of fingers in case of accidental start-up.

(d) Clean up spilled lubricant with rags and/or absorbent.
WHY: spilled lubricant could cause slippery surface which could cause operator to slip and injure back, head, or other parts of body.

DIGESTED SLUDGE PUMP (Piston Type, Belt Driven)

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: automatic oiler is full of clean oil; oiler on eccentric strap dripping at normal rate (determined by specifications of equipment). Water supply to packing flowing enough to lubricate piston without excessive waste of water. (A permanent reservoir of heavy oil is sometimes used instead of water.) Drive belt tension approximately one inch slack with pump off, normal pumping rate shown on flow meter, pump discharge pressure, pump motor ammeter, or combination of these. Starts pumping at the desired pressure with no unusual vibrations or noises as determined by previous experience. No leaking.
ACT: operator visually observes oiler, piston water supply, supernatant flow, and digester gas pressure manometer; also looks at pumps for leaks and listens for any unusual noises. Fills automatic oiler with proper oil as designated by manufacturer's maintenance manual, and manually turns automatic oiler on when starting pump; operator looks and listens for any unusual vibrations.

2. POSSIBLE MALFUNCTIONS

(a) Sludge leaking around piston: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: tighten each packing follower nut approximately 1/8 turn with pump running and visually observe packing. Adjust packing in small increments until leak stops. If packing will not seal properly without binding piston (indicated by heat generated in packing gland), notify supervisor and refer to corrective maintenance for repacking.

(b) Lower than normal discharge pressure: seen by operator on discharge pressure gauge.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump drive motor, close suction and discharge valves, drain ball check chamber to reduce pressure, remove ball check chamber covers and inspect for sticks and rags that might be keeping the ball checks from seating evenly. Remove debris, reassemble, open valves, and restart pump.by manually turning power to pump drive motor on.

(c) Packing too tight (no dripping seal H_2O): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump drive motor. Loosen packing follower nuts one-half turn, restart pump by manually cutting power to pump drive motor on and readjust packing in small increments.
WHY: packing that is too tight can cause excessive wear on eccentric and strap, scoring of piston, sheared pins, or even a cracked cylinder. (Note: never tighten the eccentric body and flange so tight that the pin would not shear if the pump jammed or was overloaded.)

Continued

Digested Sludge Pump (Piston Type, Belt Driven)--Continued

(d) Eccentric strap heats up: seen and/or smelled by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump drive motor, feel strap. Look for: insufficient eccentric lubrication flow (determined by previous experience), packing adjustment (too tight), eccentric strap clearance (too close), viscosity of material being pumped (high).
WHY: any one or combination of the above will increase friction on the strap and create heat.

(e) Loose drive belts: seen and/or heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to pump drive motor, LOCK-OUT breaker switch, adjust belt tension to manufacturer's specifications, restart pump by manually cutting power to pump drive motor.
WHY: loose belts cause excessive wear to belts and pulleys.

(f) Suction line plugged (visual observation of suction pressure gage): seen by operator.
REF: plant operations manual.
IMM OP ADJ: manually cut power to pump drive motor, close pump suction valve, open backflushing line, close backflushing line, open pump suction valve, start pump by manually cutting power to pump drive motor, observe pump discharge pressure.

(g) Pump running but no sludge is being discharged and/or discharge pressure gage shows no pressure: sludge seen and gage read by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(h) Pump leaking (excessive amount of water around gland): seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(i) Pump pulley turning but piston not working: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(j) Motor running but pump pulley not turning: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

Continued

(k) Pump knocking or making unusual noise: heard by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

(l) Motor not running: seen by operator.
REF: pump manufacturer's maintenance manual.
IMM OP ADJ: manually shut down pump by turning pump motor control switch to OFF and start alternate pump. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: pump manufacturer's maintenance manual.
FREQ: monthly.
COND:
(a) Frayed, slack, or cracked belt: seen by operator as he presses belt.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Observe oil in gear box for proper amount by looking at sight gage or dipstick; add oil if necessary.

(d) Clean up any spilled oil with rags and/or absorbent.

(e) Use screwdriver to tighten screws in pulleys.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(b) Remove drain plug with wrench and completely drain old oil.

(c) Repalce drain plug with wrench and fill to FULL level on gage with proper oil as designated by the manufacturer's maintenance manual.

(d) Manually remove gear box cover, look for worn teeth (teeth not meshing at least one quarter of an inch), and broken (cracked) teeth. Determine, by trying to move with hand if gears are loose on shaft (if loose, tighten with allen wrench).

(e) Manually replace gear box cover.

(f) Fill gear box to the correct level (indicated by previous experience or by markings on box) with the proper oil designated by the manufacturer's maintenance manual.

(g) Clean up any spilled oil with rags and/or absorbent.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

FREQ: annually.
COND:
(a) Plunger piston loose in cylinder (wobbles) or scratched (normally smooth surfaced): seen by operator.
ACT: refer to corrective maintenance.
GEN ACT:
(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Manually close suction and discharge valves and drain pump before opening pump case.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Manually remove ball checks, accurately determine wear as pointed out in the pump manufacturer's maintenance manual. If wear is excessive, refer to corrective maintenance for replacement.

Continued

Digested Sludge Pump (Piston Type, Belt Driven)--Continued

(e) Visually inspect ball seats for cracks or broken places. Repair if necessary as indicated by manufacturer's maintenance manual.

(f) Visually inspect upper bearing and eccentric strap clearances. Restore to manufacturer's specifications as indicated by specifications if conditions are not up to conditions in specifications.

(g) Close pump case and manually open suction and discharge valves.

(h) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the equipment.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Manually close suction and discharge valves and drain pump before opening pump case.
WHY: to prevent splashing of waste on operator which could cause sickness to operator.

VALVES

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: valves that should be open are open; valves that should be closed are closed (valve positions to be obtained from supervisor).
ACT: operator looks at the position indicator of each valve.

2. POSSIBLE MALFUNCTIONS

(a) Handle frozen: felt by operator (tries to turn handle).
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(b) Broken stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(c) Leaking around stem: seen by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(d) Valve turns hard: felt by operator (tries to turn valve).
REF: valve manufacturer's instruction manual.
IMM OP ADJ: refer to corrective maintenance.

(e) Valve turns easily but won't close completely: seen and felt by operator.
REF: valve manufacturer's instruction manual.
IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE
REF: valve manufacturer's maintenance manual.
FREQ: monthly.
COND: none.
GEN ACT:
(a) Wipe old grease from valve stem with rags.

(b) Regrease with proper amount and type of lubricant as designated by valve manufacturer's maintenance manual.

(c) Use the proper size and type of valve handle to move valve through one complete cycle (completely open, then completely closed). If it does not completely open (close), refer to corrective maintenance.

(d) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Valves--Continued

4. MAJOR SAFETY FACTORS

(a) Use the proper size and type of valve handle when turning valves. WHY: improper type valve handle may slip and cause injury to the operator.

PIPING

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: no visible leaks except for possible minor leak (dripping or thin film on surface).
ACT: operator looks at all pipe and fittings that are visible. Operator makes record of any minor leak, wipes up film, observes leak for length of time to determine severity of leak. If leak is determined to be severe enough, operator notifies supervisor.

2. POSSIBLE MALFUNCTIONS

(a) Major leak (steady stream, gushing of water): seen by operator.
REF: plant developed operational manual.
IMM OP ADJ: alter valve arrangement to bypass leak, manually close valves to isolate leak, and start alternate unit. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: plant developed maintenance manual.
FREQ: semi-annually.
COND:
(a) Cracks in expansion joints: seen by operator.
ACT: for replacement, refer to corrective maintenance.

(b) Minor leaks (dripping): seen by operator.
ACT: repair by tightening joints that leak as specified in maintenance manual. Patch leaks along joints of pipe with material specified in plant developed maintenance manual.

GEN ACT:
(a) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(b) Remove cracked and peeling paint and rust with wire brush.

(c) Repaint with proper kind and color of paint as designated in plant developed maintenance manual.

(d) Tighten all hose support brackets with wrench.

(e) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

GAS METER (Production)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: gas meter component dial is turning forward at normal rate as indicated by previous experience.
   ACT: operator looks at the gas meter and notes that the component dial is turning.
   FREQ: once daily.
   COND: none.
   ACT: operator reads all the gas meter dials and records reading on the daily totalizer sheet. He then subtracts yesterday's reading from today's reading.
   WHY: the daily amount of gas production of a digester is an important indication of how well the digester is operating.

2. POSSIBLE MALFUNCTIONS

   (a) Gas meter component dial is not turning: seen by operator.
   REF: plant operation manual.
   IMM OP ADJ:
   (1) Observe the valving to verify that the gas flow is valved through the meter. If it is not, open the valves.

   (2) Observe the digester pressure manometer to verify that there is digester gas pressure. If not, notify supervisor.

   (3) Observe the heat exchanger burner or waste gas for flame to verify that gas is going through the gas meter. If not, notify supervisor.

   (4) Notify supervisor if all the above items are satisfactory as specified by the plant operation manual.
   WHY: the problem is likely in the gas meter itself.

   (b) Gas meter appears to be turning too fast (based on previous experience): seen by operator.
   REF: gas meter manufacturer's maintenance manual.
   IMM OP ADJ: notify supervisor for maintenance action.

3. PREVENTIVE MAINTENANCE
   REF: gas meter manufacturer's maintenance manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Manually isolate the gas meter by valving the gas flow through the meter bypass line.

   (b) Provide adequate ventilation while working on gas meter.
   WHY: accumulations of digester gas create an explosive/fire hazard which could cause death or injury to operator.

   (c) Disassemble the gas meter and clean as designated by the manufacturer's instructions.

Continued

(d) Assemble the gas meter, add damping fluid as directed by manufacturer's maintenance manual, and manually valve the meter back in service.

(e) Look for leaks by painting joints with a soapy water solution. If leaking, refer to corrective maintenance for repair.

(f) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Provide adequate ventilation while working on gas meter. WHY: accumulations of digester gas create an explosive/fire hazard which could cause death or injury to operator.

GAS MANOMETERS

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: the digester gas dome shows a positive pressure indication on the gas manometer.
ACT: operator observes that the liquid level in the digester gas dome leg of the "U" tube manometer is below the liquid level of the atmosphere leg.
WHY: the digester might suck in air and create an explosive mixture in the gas dome if a negative pressure condition should occur.

2. POSSIBLE MALFUNCTIONS

(a) Digester gas pressure is in excess of determined limit set by previous operation of unit (measured on manometer): seen by operator.
REF: plant operation manual.
IMM OP ADJ: verify by observation that supernatant overflow is running freely, digester pressure relief valve works freely, waste gas burner line is open, and waste gas regulator works freely. If any of the above conditions are not functioning as indicated by plant operation manual, refer to corrective maintenance. If all of the above meet specification, then notify supervisor.

(b) Digester gas pressure shows a partial vacuum (measured on manometer): seen by operator.
REF: plant operation manual.
IMM OP ADJ: manually shut off the main gas valve from the digester gas dome. Manually shut off any valves that might be draining liquid from the digester. Notify the supervisor.
WHY:
(1) A negative gas dome pressure could create an explosive condition by sucking air.
(2) A negative pressure in the gas dome could cause the roof to collapse.

3. PREVENTIVE MAINTENANCE
REF: plant operation manual.
FREQ: monthly.
COND:
(a) Water column is low in both legs: seen by operator.
ACT: add water to "U" tube by method from plant operation manual to raise liquid level to normal height indicated on tube.
WHY: if the water levels get too low, the gas water seal effect may be lost and digester gas will escape into the room creating a hazardous condition.

Continued

Gas Manometers--Continued

(b) "U" tube is dirty inside: seen by operator.
ACT: manually turn off gas supply, remove and clean the "U" tube, add correct amount of liquid as indicated on tube and specified by plant operation manual.
WHY: a dirty manometer might be misread.

GEN ACT:

(a) Inspect for preceding conditions in indicated manner and perform maintenance if necessary. If tube needs to be touched, handle carefully to prevent breakage.

(b) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Maintain the gas water seal at all times.
WHY: to prevent explosive gas from venting through the manometer "U" tube which could cause illness or death to operator.

(b) Handle "U" tubes carefully while performing any maintenance.
WHY: to prevent breakage of glass that could cause serious cuts to operator.

GAS WATER TRAPS (Condensate)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: trap valve opens and closes as handle is moved to OPEN or CLOSED; when operator moves handle to DRAIN, water drains from trap with no hindrance from material clogged in trap.
   ACT: operator moves handle to OPEN and CLOSED positions and verifies by observation that the trap valve opens and closes; operator moves handle to DRAIN and verifies by observation that the flow of water from trap is uninterrupted by clogged materal.

2. POSSIBLE MALFUNCTIONS

   (a) Valve does not move when handle is moved: seen and/or felt by operator.
   REF: trap manufacturer's manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

   (b) Gas leakage when valve handle is at DRAIN position or FILL position: seen and smelled by operator.
   REF: trap manufacturer's manual.
   IMM OP ADJ: manually close isolation valve, notify supervisor and refer to corrective maintenance.
   WHY: escaping gas could ignite causing an explosion or fire.

   (c) Valve does not completely open (close) when handle is moved to OPEN or CLOSED: seen by operator.
   REF: trap manufacturer's manual.
   IMM OP ADJ: notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: trap manufacturer's manual.
   FREQ: semi-annually.
   COND:
   (a) Water not draining freely from trap (clogged with material): seen by operator.
   ACT: clean trap as follows:
   (1) Manually close isolation valve.
   WHY: to minimize leakage of gas when trap is removed.
   (2) Manually remove trap and disassemble by using instructions from trap manufacturer's manual.
   (3) Clean the trap with brush, hand, and scraper. Smooth down any rough surface with brush.
   (4) Manually reassemble and reinstall following procedure outlined in manual.
   GEN ACT:
   (a) Inspect for preceding condition and perform indicated maintenance if necessary.

Continued

(b) Inspect for gas leaks by turning valve handle to DRAIN position or FILL position; smell with shallow breath for gas fumes. If gas fumes are present, notify supervisor and refer to corrective maintenance.

(c) Enter all preventive maintenance on equipment record card. WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually isolate with valve and repair immediately any trap leaking gas.
WHY: to prevent injury or death to operator due to explosion or fire.

(b) Minimize leakages of gas when removing or replacing trap.
WHY: to minimize danger of explosion or fire which could injure or kill operator.

GAS PRESSURE AND VACUUM RELIEF VALVES (Digester Cover)

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: digester gas pressure within normal range (8 to 12 inches water column), pressure relief valve closed, vacuum relief valve closed.
   ACT: operator reads digester gas manometer; if reading is not normal, notifies supervisor and refers to corrective maintenance. Operator sniffs down wind from relief valve to detect any leaking gas. If operator smells gas, he notifies supervisor.

2. POSSIBLE MALFUNCTIONS

   (a) Valves leaking gas: smelled and/or heard by operator.
   REF: valve manufacturer's manual.
   IMM OP ADJ: look at digester gas manometer pressure.
   (1) If normal (not exceeding setting of pressure relief valve), notify supervisor and refer to corrective maintenance.

   (2) If manometer pressure is above pressure setting on relief valve, stop all pumping into the digester and look at supernatant overflow line. If it is flowing freely, look at all digester operating procedures to determine cause of increased pressure. Notify supervisor and refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
   REF: valve manufacturer's manual.
   FREQ: annually.
   COND: none.
   GEN ACT:
   (a) Avoid open lights or smoking when working in digester area.

   (b) Provide for alternate pressure relief control by procedure set by the valve manufacturer's manual or vent digester to atmosphere.

   (c) Manually remove and disassemble component as indicated by valve manufacturer's manual.

   (d) Inspect by observation all valve faces, seats, guides, spring tension, and weights. Repair or adjust if any part does not meet the specifications set by the manufacturer's manual.

   (e) Manually reassemble component and install as indicated by valve manufacturer's manual.

   (f) Inspect for odors and/or sound of leaking gas. If leaking gas detected, notify supervisor.

   (g) Enter all preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

Gas Pressure and Vacuum Relief Valves (Digester Cover)--Continued

4. MAJOR SAFETY FACTORS

(a) Avoid open lights or smoking when working in digester area. WHY: to prevent ignition of digester gas which could cause an explosion or fire resulting in injury or death to operator.

FLAME ARRESTORS (Gas Piping)

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: free flow of gas through flame arrestor [indicated by normal operation (known by previous experience) of components downstream from flame arrestor]. Normal pressure drop (designated by manufacturer's manual) across component (if pressure gages are installed immediately before and after component in line).
ACT: operator observes operation of components downstream from flame arrestor; operator observes pressure drop across the component. If there is not a free flow of gas or a normal pressure drop, the operator notifies supervisor.

2. POSSIBLE MALFUNCTIONS

(a) Flow restricted through component by accumulation of foreign materials (indicated by abnormal pressure drop through component): seen by operator.
REF: flame arrestor manufacturer's manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance for cleaning.

3. PREVENTIVE MAINTENANCE
REF: flame arrestor manufacturer's manual.
FREQ: semi-annually.
COND: none.
GEN ACT:

(a) Provide ventilation sufficient to remove any accumulation of gas due to opening gas piping.

(b) Isolate flame arrestor as indicated by flame arrestor manufacturer's manual.

(c) Disassemble component as indicated by flame arrestor manufacturer's manual.

(d) Clean internal parts and seal faces as directed by flame arrestor manufacturer's manual.

(e) Reassemble component.

(f) Put arrestor in service as indicated by flame arrestor manufacturer's manual.

(g) Inspect seal areas for gas leaks by daubing soap suds along gasket edges and around bolt heads. If leaks are found, refer to corrective maintenance for repair.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

Continued

4. MAJOR SAFETY FACTORS

(a) Provide ventilation sufficient to remove any accumulation of gas due to opening gas piping.
WHY: to prevent accumulations of digester gas that create a potential explosion/fire hazard which can result in injury or death to operator.

FLOATING COVER

1. NORMAL PROCEDURE
FREQ: at least once every 4 hours.
COND: the digester cover is floating level above the corbels and below the high level alarm point; the rim is free of foam, and the gas flex hoses are not leaking or kinked. Sun blanket inside the dome is within its established depth below the dome roof.
ACT: operator looks at the floating cover and observes the above conditions. The operator also looks into the gas dome's glass inspection ports and observes that the scum blanket is within its established depth below the dome roof.
WHY:
   (a) A cover that tips due to uneven floatation might jam on the digester side walls and cause serious structural damage.

   (b) The fact that the flexible hoses move makes them prone to developing leaks sooner or later.

2. POSSIBLE MALFUNCTIONS

   (a) Floating cover is tipped: seen by operator.
   REF: plant manual, prints.
   IMM OP ADJ: manually shut off all sludge flow into the digester. Manually shut off supernatant or digester sludge flow out of the digester. Notify supervisor.
   WHY: further pumping into or out of the digester may cause the cover to tip more. This might cause serious structural damage or uncontrolled release of explosive digester gas.

   (b) Floating cover level is too high (at or above the alarm point): seen by operator.
   REF: plant operation manual.
   IMM OP ADJ: manually shut off all flow into the digester. Notify supervisor.
   WHY: if the floating cover gets so high that the guide rollers are above the digester walls the cover might tip and jam when the liquid level is lowered.

   (c) Floating cover level is too low (on or nearly on the corbels): seen by the operator.
   REF: digester construction prints.
   IMM OP ADJ: manually shut off all flow out of the digester. Notify supervisor.
   WHY: if the digester liquid level is lowered after the floating cover is resting on the corbels, the liquid seal will be lost. This will allow uncontrolled release of odorous and explosive digester gas.

   (d) Scum level is uneven or higher than usual: seen by operator through glass inspection ports.
   REF: plant records (past observations), experience.
   IMM OP ADJ: notify supervisor.
   WHY: an abnormally high or uneven scum blanket may cause the digester floating cover to tip.

Continued

Floating Cover--Continued

(e) Foaming is occuring between the floating cover side walls and the inside of the digester walls: seen by operator.
REF: plant manual.
IMM OP ADJ: look into the dome inspection ports. Note if evidence of foaming can be seen inside the digester. Notify supervisor.
WHY: foaming indicates a serious upset in the digester biological process which may produce further problems if not corrected.

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3. PREVENTIVE MAINTENANCE
REF: digester manufacturer's maintenance manual.
FREQ: weekly (or as needed).
COND:
(a) Seal liquid has thick scum on the surface around the inside of the digester tank walls: seen by operator.
ACT: hose around the floating cover's side walls with high pressure process water.
WHY: to keep the seal liquid fluid so a good seal will be maintained at all times.
GEN ACT:
(a) Avoid smoking on or near the digester floating cover. Keep all open flames and sparks away from the digester area.

(b) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(c) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.
FREQ: semi-annually.
COND: none.
GEN ACT:
(a) Avoid amoking on or near the digester floating cover. Keep all open flames and sparks away from the digester area.

(b) Use non-sparking tools when working on the floating cover equipment.

(c) Grease floating cover side roller guides with recommended lubricant designated in digester manufacturer's maintenance manual.

(d) Adjust roller guide clearance as indicated in maintenance manual to maintain equal spacing of cover all around digester tank walls.

(e) Look for gas leaks by coating flanges, joints, and flex hoses with a soapy solution. If leaks are observed, refer to corrective maintenance.

(f) Use grease gun to grease rollers on hinged catwalk with proper type and amount of lubricant as indicated by maintenance manual.

Continued

Floating Cover--Continued

(g) Clean up spilled lubricant with rags and/or absorbent.

(h) Paint brackets, piping, or other equipment on floating cover that are chipped, rusted, or marred.
WHY: to prevent corrosion.

(i) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Avoid smoking or near the digester floating cover. Keep all open flames and sparks away from the digester area.
WHY: to prevent ignition of escaping gas combined with right mixture of air causing explosion or fire resulting in injury or death to operator.

(b) Use non-sparking tools when working on the floating cover equipment.
WHY: to prevent ignition of escaping gas combined with right mixture of air causing explosion or fire resulting in injury or death to operator.

MOTOR (Gas Storage Compressor)

1. NORMAL PROCEDURE
   FREQ: at least once every 4 hours.
   COND: motor temperature within range on name plate, free of vibration, running with normal even humming sound, shaft turning, and bearing temperature normal (can hold hand on bearing housing for at least 30 seconds).
   ACT: operator turns control switch to HAND (if component is off) and makes the following observations: listens for unusual sounds, feels motor and bearing housing for vibration and heat. Operator turns control switch back to AUTO.

2. POSSIBLE MALFUNCTIONS

   (a) Motor won't run (shaft not turning): seen and/or heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: operator manually resets power source overload protection device by pressing reset button in switch gear. If when reset, motor won't run manually, turn power to motor OFF at control switch. Notify supervisor and refer to corrective maintenance before proceeding.

   (b) Motor too hot (cannot hold hand firmly on motor for at least 30 seconds): felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; notify supervisor and refer to corrective maintenance.

   (c) Excessive vibration: seen or felt by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Refer to corrective maintenance and notify supervisor.

   (d) Unusual noise: heard by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to motor by turning control switch to OFF; start alternate pump. Notify supervisor and refer to corrective maintenance.

   (e) Scorched paint or black stains on motor housing: seen by operator.
   REF: motor manufacturer's maintenance manual.
   IMM OP ADJ: manually cut power to pump motor by turning control switch to OFF. Notify supervisor and refer to corrective maintenance.

Continued

(f) Smoke rising out of casing: seen and/or smelled by operator.
REF: motor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to motor by turning control switch to OFF. Refer to corrective maintenance.

3. PREVENTIVE MAINTENANCE
REF: motor manufacturer's maintenance manual.
FREQ: monthly.
COND:

(a) Chipped or broken concrete around motor base: seen by operator.
ACT: tighten all motor mount bolts with wrench.
WHY: loose motor mounts permit vibration which will damage equipment resulting in high repair costs and/or excessive down time.

(b) Smoke and/or smoke stains and scorched paint: seen and/or smelled by operator.
ACT: determine amperage of motor with ammeter. If motor is drawing excessive amperage, refer to corrective maintenance.
WHY: if motor is drawing excessive amperage (greater than that stamped on data plate), a fire could occur.

(c) Loose electrical connections (connections able to be moved by pressing with blade of insulated screwdriver): operator presses connections with insulated screwdriver.
ACT:
(1) Manually turn control switch to OFF.
(2) Tighten connections with screwdriver.
(3) Manually turn control switch to ON.
WHY: arcing from loose connectors could cause overheating of motor and fire.

GEN ACT:

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

(b) Use ladder and harness when preventive maintenance is done at a dangerously high (low) position.

(c) Inspect for preceding conditions in indicated manner and perform maintenance if necessary.

(d) Tighten end plate bolts with a wrench.
WHY: loose bolts will permit the motor to become misaligned.

Continued

(e) Use grease gun to apply proper amount of the correct lubricant as directed by motor manufacturer's maintenance manual.
WHY: wrong lubricant and too much or too little lubricant will damage bearings, seals, and motor windings.

(f) Clean up all excessive or spilled lubricant with rags or oil absorbent.
WHY: lubricant will accumulate dirt and dust thereby producing a fire hazard.

(g) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(h) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause injury or death to operator.

(b) Clean up all spilled lubricant with rags and/or absorbent.
WHY: lubricant will produce slippery conditions resulting in falls and bodily injury.

(c) Use safety ladders and harness if motor is located in an area that is difficult to reach.
WHY: to prevent falls and resulting injury.

GAS STORAGE COMPRESSOR (Piston Type, Belt Driven)

1. NORMAL PROCEDURE

FREQ: at least once every 4 hours.
COND: compressor running smoothly, normal noise level as indicated by previous running, gear box temperature normal (can hold hand firmly on gear box for at least 30 seconds), no hot spots on compressor casing, oil level normal (indicated on oil stick), drive belts running smoothly, drive belts in good condition (no rips, cracks, or other deterioration visible to the eye), discharge pressure normal (indicated on pressure gage), possible small oil leaks (film).
ACT: operator listens to compressor for above conditions; feels gear box and compressor casing for temperature conditions stated above; operator looks at oil level and discharge pressure readings; listens for smooth running of drive belt while compressor running; looks at drive belt while compressor running; looks at drive belt while compressor is not running; looks for any small oil leaks (film). (If any found, operator wipes down equipment and notes leak for future inspection.)
WHY: to prevent further damage to component due to excessive temperature and/or vibration which are indications of mechanical abnormalities.

2. POSSIBLE MALFUNCTIONS

(a) Excessive vibration: felt or seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor. Notify supervisor and refer to corrective maintenance.

(b) Excessive gear box temperature: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor and notify supervisor.

(c) Hot spots on compressor casing: felt by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor. Notify supervisor and refer to corrective maintenance.
WHY: hot spots indicate increased friction inside the case which in turn indicates a build up of foreign material or mechanical misalignment.

(d) Large oil leaks (puddle): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually cut power to compressor drive motor and notify supervisor.
WHY: low oil levels can cause extensive mechanical damage.

(e) Drive motor and compressor misalignment (possibly indicated by rapid wearing on drive belts): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor and refer to corrective maintenance.
WHY: misalignment of drive unit and belts places abnormal stress on compressor components and will cause excessive wear.

Continued

(f) Compressor automatically shuts down due to safety device operation (trips alarm): seen by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to drive motor to OFF. Determine which alarm shuts the compressor down (whether low on pressure, low cooling water pressure, low gas suction pressure, low cylinder oil level, high gas temperature, or high oil temperature). Notify supervisor, correct problem as directed by compressor manufacturer's maintenance manual if possible, or refer to corrective maintenance if necessary.
WHY: alarm conditions must be taken care of before trying to restart the compressor, to prevent causing damage to the compressor.

(g) Loading valves not seating: observed by operator.
REF: compressor manufacturer's maintenance manual.
IMM OP ADJ: manually turn power supply switch to compressor drive to OFF. Notify supervisor and refer to corrective maintenance.
WHY: compressor will not pump properly if loading valves do not seat.

3. PREVENTIVE MAINTENANCE
REF: compressor manufacturer's maintenance manual.
FREQ: semi-annually.
COND:
(a) Output of compressor has reduced at increased rate: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.

(b) Internal wear (rotor worn) exceeds manufacturer's tolerance allowance: seen by operator.
ACT: notify supervisor and refer to corrective maintenance.
GEN ACT:
(a) Avoid smoking or open flames (welding, brazing, flame soldering) in areas that may contain digester gas (including digester roof top).

(b) Inspect for output condition of compressor in indicated manner.

(c) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause damage to equipment.

Continued

(d) Perform maintenance for output condition of compressor if necessary. (Refer any work that involves dismantling and reassembling of a compressor of this design to a qualified machinist.)
WHY: repairs require specialized knowledge and tools.

(e) Inspect for internal wear in indicated manner and perform maintenance if necessary. (Refer any work that involves dismantling and reassembling of a compressor of this design to a qualified machinist.)
WHY: repairs require specialized knowledge and tools.

(f) Remove red LOCK-OUT-TAG, unlock electrical power supply switch and turn it to ON, manually turn motor control switch to ON(HAND) to verify component is operational. Turn switch to AUTO.

(g) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Avoid smoking or open flames (welding, brazing, flame, soldering, etc.) in areas that may contain digester gas (including digester roof top).
WHY: digester gas is flammable and may cause a fire or explosion which could result in injury or death to operator.

(b) Manually turn motor control switch to OFF, padlock electrical power supply switch in OFF position, and place red LOCK-OUT-TAG on power box for switch before performing any work on the component.
WHY: to prevent automatic start-up or another person from starting motor which could cause serious injury to operator.

GAS STORAGE TANKS

1. NORMAL PROCEDURE
FREQ: at least once every 8-hour shift.
COND: pipe connections to tank(s) are tight, no hint of gas leakage (such as odor, sound, vapor on surface of tank), condensate traps draining water from tank, pressure in system within predetermined operational levels, pressure relief valves seated.
ACT: operator looks at tank(s), pipes connected to tanks, and pipe connections. Manually inspects connections for tightness, feels piping for vibration and leaks; operator listens for leaks and smells air for odor levels in area. Operator opens and closes condensate trap(s); looks at reading on pressure gage and pressure relief valve(s).

2. POSSIBLE MALFUNCTIONS

(a) Gas leaks (increased odor in immediate area of leak, sound of leaking gas, feeling gas flowing on fingers): detected by operator.
REF: plant design manual.
IMM OP ADJ: allow no smoking or open flame in area; notify supervisor and isolate leak from system by manually closing upstream and downstream valves. Mark leak area (small leaks can be pinpointed by painting soap and water solution on suspected area and observe bubbles).

(b) Pressure relief valve unseated: seen by operator.
REF: condensate trap manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor, isolate tank from system by manually closing upstream and downstream valves. (In a one tank system, manually cut power to gas compressor.)

(c) Condensate trap not draining water from tank: seen by operator.
REF: condensate trap manufacturer's maintenance manual.
IMM OP ADJ: notify supervisor.
WHY: water retained in tank reduces gas storage volume and may damage tank.

3. PREVENTIVE MAINTENANCE
REF: plant design manual.
FREQ: annually.
COND:
(a) Exposed surfaces weathering or rusting: seen by operator.
ACT: clean off exposed surfaces with wire brush to get rid of roughness and rust. Apply to surface the paint designated for this purpose in the plant design manual. (Avoid smoking or open flame in area that contains gas.)

Continued

GEN ACT:

(a) Avoid smoking or open flames (welding, brazing, and flame soldering) in areas that may contain digester gas.

(b) Inspect for preceding condition in indicated manner and perform maintenance if necessary.

(c) Enter all preventive maintenance on equipment record card.
WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS

(a) Avoid smoking or open flames in areas that may contain digester gas.
WHY: digester gas is flammable and may cause a fire or explosion which could result in injury or death to operator.

FIRST AID KIT

1. NORMAL PROCEDURE
   FREQ: at least once every 8-hour shift.
   COND: first aid kit in proper place and contains proper supplies listed on inventory sheet in kit.
   ACT: operator opens first aid kit and compares supplies on hand with inventory sheet; replaces any missing supplies.
   WHY: first aid kit should be readily available in case of operator injury.

2. POSSIBLE MALFUNCTIONS

   (a) Kit is missing: seen by operator.
   REF: none.
   IMM OP ADJ: notify supervisor and replace kit with a new kit.

   (b) Kit is damaged (case will not close; water, rodents contaminate supplies); seen by operator.
   REF: first aid kit manual.
   IMM OP ADJ: notify supervisor and replace or repair kit.

3. PREVENTIVE MAINTENANCE
   REF: first aid kit manual or supplies list in kit.
   FREQ: at least once every week.
   COND:
   (a) Some supplies missing: seen by operator.
   ACT: determine actual amount of supplies missing.
   GEN ACT:
   (a) Operator replenishes first aid supplies by using inventory sheet in lid and list of supplies he has decided is missing.

   (b) Enter preventive maintenance on equipment record card.
   WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None

FIRE FIGHTING EQUIPMENT

1. NORMAL PROCEDURE

   FREQ: at least once every 8 hours.
   COND: fire fighting equipment in proper place (designated by supervisor) and has been inspected within the last month by plant fire marshal.
   ACT: operator looks at inspection tag of fire fighting equipment and note location. If inspection time has elapsed, notify fire marshal.
   WHY: fire fighting equipment should be readily available in case of fire.

2. POSSIBLE MALFUNCTIONS

   (a) Equipment missing: observed by operator.
       REF: none.
       IMM OP ADJ: notify supervisor.

   (b) Equipment damaged: observed by operator.
       REF: fire fighting equipment maintenance manual.
       IMM OP ADJ: notify supervisor.

3. PREVENTIVE MAINTENANCE

   REF: fire fighting equipment maintenance manual.
   FREQ: annually.
   COND:
   (a) No known use of extinguisher since last recharge (CO_2, dry chemical) but weight seems light: felt by operator.
       ACT: obtain information from supervisor or other personnel at plant if extinguisher has been used.
   GEN ACT:
   (a) Weigh extinguisher and compare with weight stamped on it, (CO_2).
       WHY: low weight indicates extinguisher should be recharged.

   (b) Observe pressure gage on extinguisher (dry chemical) to see that needle is pointing in position that shows pressure is not low.

   (c) If pressure is low, extinguisher should be recharged by referring to the equipment maintenance manual.

   (d) Enter all preventive maintenance on equipment record card.
       WHY: to show work performed for cost accounting and to indicate equipment replacement time.

4. MAJOR SAFETY FACTORS--None